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Original article

Validation of the Thai version of SARC-F, MSRA-7, and MSRA-5 questionnaires compared to AWGS 2019 and sarcopenia risks in older patients at a medical outpatient clinic

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ABSTRACT

Objectives: To validate the Thai Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls (SARC-F), and 2 Mini Sarcopenia Risk Assessment (MSRA-5, and MSRA-7) questionnaires for sarcopenia screening in older patients in the medical outpatient setting, and to assess the improvements of the diagnostic accuracy by adapting the parameters in the SARC-F, MSRA-7, and MSRA-5 questionnaires. Risk factors for sarcopenia are also investigated.

Methods: Thai SARC-F, MSRA-7, and MSRA-5 questionnaires were translated backwards and forwards. Content validity and test–retest reliability were analyzed. Reliability analysis was used for SARC-F, MSRA-7, and MSRA-5 scores to increase the sensitivity and specificity. The sensitivity, specificity, likelihood ratio, and area under the receiver operating characteristic curves (AUCs) were analyzed.

Results: The prevalence of sarcopenia was 22.7% (65 of 286 patients). The sensitivity of the SARC-F, MSRA-7, and MSRA-5 questionnaires was 21.5%, 72.3%, and 61.5%, respectively. The specificity was 93.7%, 43%, and 67.4%, respectively. The AUCs were 0.58, 0.58, and 0.65, respectively. After weighting and adjusting the scores for the least responded-to items of the MSRA-5, the sensitivity increased to 82.6%, specificity to 43.4%, and AUC to 0.65. Multivariate analysis showed that the associated factors of sarcopenia were age [odds ratio (OR) = 5.92], body mass index < 18.5 [OR = 9.59], and currently working [OR = 0.11].

Conclusions: The modified MSRA-5 improved the sensitivity and diagnostic accuracy for screening for sarcopenia. It is potentially useful for screening for sarcopenia in settings with limited resources for bioelectrical impedance analysis, time, or health personnel.

1. Introduction

Sarcopenia is a syndrome involving a decrease in muscle mass [1]. The reduction in muscle mass begins at the age of 50 years old, with the muscles decreasing by 1.5% per year, then by 3% per year in patients older than 60 years old. The effects of sarcopenia on older people include an increased risk of falls, rates of institutionalization and hospitalization, dependency, and mortality when compared to those who do not have sarcopenia [2–5]. The prevalence of sarcopenia in community-dwelling Thai adults aged 60 years old or over varies between 9.6% and 30.5% depending on participants' characteristics and the measurement technique [6,7].

Currently, the gold standard diagnostic criteria for sarcopenia in Asian populations are the criteria proposed by the Asian Working Group for Sarcopenia 2019 (AWGS 2019) [8]. Diagnosis is based on the presence of decreased muscle mass and the presence of either low muscle strength or poor physical performance as follows. Muscle mass is measured by dual-energy X-ray absorptiometry (DXA) or bioelectrical impedance analysis (BIA). Appendicular skeletal muscle mass (ASM) is defined as the sum of the muscle

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mass of the 4 limbs, and the appendicular skeletal mass index (ASMI) can be calculated as ASM/height^2 (kg/m^2). The cut-off values for BIA strength in men and women are less than 7 kg/m^2 and 5.7 kg/m^2, respectively. Low muscle strength is measured by using a hand-held dynamometer. The cut-off values for handgrip strength in men and women are less than 28.0 and 18.0 kg, respectively. A 6-meter usual gait speed of less than 1 m/second indicates poor physical performance.

The method of measuring sarcopenia using DXA or BIA has several limitations, such as the availability of the machine, and the cost of the routine examination in every older patient. Therefore, this limits the implementation of proactive routine screening. The SARC-F questionnaire [9] was consequently developed and used to screen sarcopenia in AWGS 2019 [8]. A meta-analysis of the SARC-F questionnaire compared with AWGS criteria demonstrated a sensitivity of 14% and specificity of 93% [10], which have limited its use in screening for sarcopenia due to the low sensitivity. In 2017, 2 Mini Sarcopenia Risk Assessment (MSRA-7 and MSRA-5) questionnaires were developed, and these demonstrated higher sensitivity than the SARC-F questionnaire [11]. The sensitivity of the MSRA-7 and MSRA-5 questionnaires was 86.9% and 90.2%, and the specificity was 39.6% and 70.6%, respectively [12].

Several factors were reported to be associated with sarcopenia, such as age [13–20], a low level of physical activity [13–19], low BMI [21,22], smoking [13,22], polypharmacy [14,22], diabetes [14,22], and multiple comorbidities [20]. On the other hand, a physically active condition and adequate energy intake (especially protein intake) may be protective factors for sarcopenia [23–25]. Studies in Thailand demonstrated older age, low BMI, and low physical performance were associated with sarcopenia, but they did not investigate the effects of the comorbidities, polypharmacy, and potentially protective factors [6,7]. Therefore, these factors are examined in this study.

These 3 questionnaires have never been translated into and validated in the Thai language. Consequently, the purpose of this study was to translate and validate these questionnaires for screening for sarcopenia in Thailand in places where there are limited resources and budget. This may be generalized to the whole country, especially in primary and community care. Furthermore, the associated factors for sarcopenia are also investigated for sarcopenic prevention and management.

2. Methods

2.1. Translation

The questionnaires were translated into Thai by a bilingual English teacher from the I-Style Language School. The SARC-F is composed of 5 questions (Table 1). In the question about strength (item 1), the explanation “Three 1.5-L bottles of drinking water” was added as an example of 10 pounds (4.5 kg). The total score ranges from a minimum of 0 points to a maximum of 10 points. A diagnosis of sarcopenia is made for a total score of 4 or higher. The MSRA-7 and MSRA-5 questionnaires are composed of 7 and 5 questions, respectively (Table 2). The total score for the MSRA-7 ranges from a minimum of 0 points to a maximum of 40 points, and a total score of 30 points or less indicates sarcopenia. The total score for the MSRA-5 ranges from a minimum of 0 points to a maximum of 60 points, and a total score of 45 points or less indicates sarcopenia. A blind backward translation was performed by the bilingual pharmacist. The blind content validity index (CVI) was performed after a forward and backward translation by 3 consultant geriatricians for providing reliable empirical information regarding the quality of the instruments. The acceptable CVI was 0.8 or more [26,27].

2.2. Study design and participants

We conducted a cross-sectional study at Bangkhunthian Geriatric Hospital and Siriraj Hospital in Bangkok, Thailand. Bangkhunthian Geriatric Hospital represents a population group in a small hospital, while Siriraj Hospital is a tertiary hospital and a medical school representing a population group in a large hospital. The Institutional Review Board, Faculty of Medicine Siriraj Hospital (SIRB) approved the human research ethics for this study (COA no. Si 538/2019). Written informed consent was obtained from all participants (or their legal proxies). From September to December 2019, general medicine outpatients (OPD) aged 60 years old or older were approached and recruited through a convenient sampling method if they met the inclusion criteria. Individuals with the following conditions were excluded: patients who could not stand, walk, or hold a grip, or who had an implanted pacemaker or metallic device, severe dementia, or were unable to communicate in the Thai language.

2.3. Measurement of muscle mass, handgrip strength, and 6 meter usual gait speed

The total appendicular skeletal muscle mass (ASM) was measured using bioelectrical impedance analysis (BIA) (MC-780 MA, TANITA, Tokyo, Japan), and then, the skeletal muscle mass index (SMI) was calculated [SMI (kg/m^2) = ASM/height^2]. The handgrip strength was measured using a handheld dynamometer (Grip-D, Takei Scientific Instruments Co., Ltd, Tokyo, Japan). The measurements were performed 3 times on the dominant hand while the subject was seated with the elbow flexed at a 90° angle, and the wrist placed in a neutral position. The mean of the dynamometer values was applied for the analysis [28]. Six-meter usual gait speed was calculated by dividing the time it took patients to walk a 6 meter (m) section of this course by the number of seconds it took to complete the section (using the data from the 2 m and 8 m marks from a 10 m distance). When the speed was < 1 m/second, the patient was considered to have low physical performance. All the tests were performed by 2 trained assessors, one of whom was a geriatric fellow and the other a geriatric nurse.

Table 1
SARC-F questionnaire.

1. Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0; Some = 1; A lot or unable = 2
2. Assistance in walking	How much difficulty do you have walking across a room?	None = 0; Some = 1; A lot, use aids, or unable = 2
3. Rise from a chair	How much difficulty do you have transferring from a chair or bed?	None = 0; Some = 1; A lot or unable without help = 2
4. Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0; Some = 1; A lot or unable = 2
5. Falls	How many times have you fallen in the past year?	None = 0; 1–3 falls = 1; 4 or more falls = 2
The maximum score is 10. A score of 4 or more may suggest sarcopenia.		

SARC-F, Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls.

Table 2
MSRA-7 and MSRA-5 questionnaires.

Question		Score (7 items)	Score (5 items)
1-How old are you?	≥ 70 years old	0	0
	< 70 years old	5	5
2-Were you hospitalized in the last year?	-Yes, and more than one hospitalization	0	0
	-Yes, one hospitalization	5	10
	-No	10	15
3-What is your activity level?	-I'm able to walk less than 1000 m	0	0
	-I'm able to walk more than 1000 m	5	15
4-Do you eat 3 meals per day regularly?	-No, up to twice per week I skip a meal (for example I skip breakfast or I have only milky coffee or soup for dinner)	0	0
	-Yes	5	15
5-Do you consume any of the following?	-Milk or dairy products (yogurt, cheese), but not every day	0	–
	-Milk or dairy products (yogurt, cheese) at least once per day	5	–
6- Do you consume any of the following?	-Poultry, meat, fish, eggs, legumes, ragout or ham, but not every day	0	–
	-Poultry, meat, fish, eggs, legumes, ragout or ham at least once per day	5	–
7-Did you lose weight in the last year?	- > 2 kg	0	0
	-≤ 2 kg	5	10
Maximum score for MSRA-7 is 40. A score of 30 or less may suggest sarcopenia.			
Maximum score for MSRA-5 is 60. A score of 45 or less may suggest sarcopenia.			

MSRA, The Mini Sarcopenia Risk Assessment.

2.4. Covariates

The following covariates were collected from face-to-face interviews: age, gender, educational background, working status, activities of daily living questionnaires (The Barthel Index for Activities of Daily Living: BADL [29] and The Lawton Instrumental Activities of Daily Living Scale: IADL [30]), self-reported number of falls and hospitalization, self-reported daily exertion (low, moderate, or high physical activity), self-perceived health status (poor, moderate, or good), Thai Mental State Examination (TMSE), number of daily drugs as revealed in a face-to-face interview and in a medical records review (≥ 5 drugs were defined as polypharmacy), and comorbid conditions as revealed in a face-to-face interview and by a medical records review. The question regarding smoking habits was phrased as follows: "Do you currently smoke tobacco habitually?" and could be answered with a "yes" or "no" or "already quit". The question about drinking habits was phrased as follows: "Do you have a habit of drinking alcohol?" and was also answerable with a "yes" or "no" or "already quit". If the answer was "yes", the amount and frequency of drinking would be further asked. The BMI was calculated using the following equation: BMI (kg/m^2) = body weight/$height^2$.

2.5. Statistical analysis

The samples size was calculated by using the statistical equation [31].

$$n_{se} = \frac{Z^2_{\alpha/2}}{d^2} \frac{Se\,(1-Se)}{Prev.}$$

In a previous study in China [12], the sensitivity of SARC-F was reported to be 29.5% (Se = 0.295). The prevalence of sarcopenia was 30.5% (Prev. = 0.305) [7]. The other values were $\alpha = 0.05$, $Z_{\alpha/2} = 1.96$, and d = 0.10. The sample size calculation was 261.95 ≈ 262 participants. An additional 10% was added to cover the likely drop out of some participants. The new sample size calculation was thus 286 participants.

The Thai versions of SARC-F, MSRA-7, and MSRA-5 were re-administered 3 months after the first scoring, and the test–retest reliability was evaluated using the Kappa coefficient. Reliability analysis was performed to evaluate internal consistency with a Cronbach alpha coefficient. Baseline characteristics were recorded on the basis of the presence or absence of sarcopenia. Differences in characteristics between participants were compared using the chi-square test or 2-sample *t*-test. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), negative likelihood ratio (NLR), and area under the receiver operating characteristic curve (AUC) of the 3 questionnaires were calculated using the diagnostic criteria for sarcopenia, with AWGS 2019 as the reference standard. We also analyzed the risk factors for sarcopenia by using univariate and multivariate logistic regression models. The statistical analysis was performed by using PASW Statistics 18.0 (SPSS, Inc., Chicago, IL, USA).

3. Results

3.1. Characteristics of the study population

We translated the SARC-F, MSRA-7, and MSRA-5 questionnaires from English into Thai language and the forward CVI from the 3 geriatricians was good (forward CVI for SARC-F = 0.93, MSRA-7 = 1.00, and MSRA-5 = 1.00). Then we translated the questionnaires backward into English language and the CVI was also good (backward CVI for SARC-F = 1.00, MSRA-7 = 0.95, and MSRA-5 = 0.93). The test–retest reliability of SARC-F was 72.7% (Kappa coefficient = −0.14), MSRA-7 was 90.9% (Kappa coefficient = 0.81), and MSRA-5 was 81.8% (Kappa coefficient = 0.61).

We included 286 participants (119 men and 167 women, mean age: 71.8 ± 7.8 years old). Table 3 presents the characteristics of the participants categorized by the presence or absence of sarcopenia according to the AWGS 2019 criteria. Participants with sarcopenia were older and had a lower BMI and lower TMSE. Furthermore, participants in the sarcopenia group had a higher proportion of dementia, stroke, osteoporosis, current smokers, and had the status of not currently working compared to those without sarcopenia. As compared to the non-sarcopenia groups, the sarcopenia group had significantly higher Thai SARC-F scores and lower MSRA-7 and MSRA-5 scores.

3.2. Prevalence of sarcopenia

The prevalence of sarcopenia was 22.7% (24.4% in men and 21.6% in women). Table 4 presents the results for the muscle mass,

Table 3
Characteristics of the study population according to the Asian Working Group for *Sarcopenia (AWGS)* 2019 criteria of sarcopenia.

Variable	No sarcopenia (n = 221, 77.3%)	Sarcopenia (n = 65, 22.7%)	P- value
Age, yr	70.1 (6.8)	77.5 (8.5)	< 0.001
Women	131 (59.3)	36 (55.4)	0.58
BMI, kg/m^2	24.9 (3.9)	20.7 (2.7)	0.05
Education ≤ 4 years	84 (38)	27 (41.5)	0.61
Currently working	57 (25.8)	3 (4.6)	< 0.001
Medical history			
Hypertension	126 (57)	39 (60)	0.67
Hyperlipidemia	141 (63.8)	37 (56.9)	0.32
Diabetes	54 (24.4)	13 (20)	0.46
AD and related dementia	24 (10.9)	17 (26.2)	0.002
Stroke or TIA	16 (7.2)	11 (16.9)	0.019
Knee osteoarthritis	44 (19.9)	10 (15.4)	0.41
Osteoporosis	10 (4.5)	9 (13.8)	0.008
Coronary heart disease	6 (2.7)	3 (4.6)	0.44
Cancer	12 (5.4)	4 (6.2)	0.823
Barthel ADL ≤ 12/20	2 (0.9)	2 (3.1)	0.19
Instrumental ADL ≤ 4/8	19 (8.6)	19 (29.2)	< 0.001
Polypharmacy	83 (37.6)	34 (52.3)	0.03
Number of falls per year			0.95
0	159 (72.0)	47 (72.3)	
1	35 (15.8)	13 (20.0)	
≥ 2	27 (12.2)	5 (7.7)	
Hospitalization ≥ 1 in 1 year	39 (17.6)	11 (16.9)	0.89
Current smoker	1 (0.5)	5 (7.7)	0.001
Current alcohol drinker	23 (10.4)	5 (7.7)	0.56
TMSE	26.5 (3.5)	24.2 (5.6)	< 0.001
SARC-F score	1.2 (1.6)	2.1 (1.8)	< 0.001
MSRA-7	31.3 (5.6)	28.2 (6.1)	0.03
MSRA-5	51.0 (9.6)	44.7 (10.9)	< 0.001

Values are presented as mean ± standard deviation or number (%).
BMI, Body mass index, AD, Alzheimer's disease; TIA, transient ischemic attack; ADL, activities of daily living; TMSE, Thai mental state examination; MSRA, The Mini Sarcopenia Risk Assessment; SARC-F, Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls.

Table 4
Muscle mass, handgrip strength, and 6-meter usual gait speed.

Components of sarcopenia	Men	Women	All
	n (%)	n (%)	n (%)
Muscle mass			
Normal	84 (70.6)	119 (71.3)	203 (71)
Low	35 (29.4)	48 (28.7)	83 (29)
Handgrip strength			
Normal	72 (60.5)	96 (57.5)	168 (58.7)
Low	47 (39.5)	71 (42.5)	118 (41.3)
Six-meter usual gait speed			
Normal	39 (32.8)	48 (28.7)	87 (30.4)
Low	80 (67.2)	119 (71.3)	119 (69.6)
Sarcopenia			
No	90 (75.6)	131 (78.4)	221 (77.3)
Yes	29 (24.4)	36 (21.6)	65 (22.7)
Questionnaires: positive for sarcopenia			
SARC-F	10 (34.5)	4 (11.1)	14 (21.5)
MSRA-7	25 (86.2)	22 (61.1)	47 (72.3)
MSRA-5	22 (75.9)	18 (50.0)	40 (61.5)

Values are presented as number (%).
SARC-F, Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls; MSRA, The Mini Sarcopenia Risk Assessment.

handgrip strength, and 6-m usual gait speed categorized by sex. The proportion low muscle mass measured by BIA was 29.4% in men and 28.7% in women. The women had a lower handgrip strength (39.5% in men vs 42.5% in women) and slower gait speed (67.2% in men vs 71.3% in women) than men. The corresponding prevalence of sarcopenia was 21.5%, 72.3%, and 61.5% when using the SARC-F, MSRA-7, and MSRA-5, respectively.

3.3. Comparison of SARC-F, MSRA-7, and MSRA-5 with AWGS 2019 and modified MSRA-5 scores

The classifications of sarcopenia using the SARC-F, MSRA-7, and MSRA-5 were tabulated according to the AWGS 2019 criteria (Table 5). The sensitivity, specificity, and AUC of the SARC-F were 21.5%, 93.7%, and 0.576, respectively. The sensitivity, specificity, and AUC of the MSRA-7 were 72.3%, 43%, and 0.576, respectively. The sensitivity, specificity, and AUC of the MSRA-7 were 61.5%, 67.4%, and 0.645, respectively. Due to the low sensitivity of MSRA-5 as compared to the result from the previous study (sensitivity 90.2%, specificity 70.6%) [32], the reliability analysis was checked to evaluate the Cronbach alpha coefficient overall to provide highest correlation. We weighted and adjusted the scores of the least responded-to items of the MSRA-5. Thus for MSRA-5 *"Question 2: Were you hospitalized in the last year?"*, we adjusted the scores from 15 to 2 points if the answer was no (not hospitalized), and the score was 0 points if the answer was yes. Also, for *"Question 4: Do you eat 3 meals per day regularly?"*, we adjusted the score from 15 to 2 points if the answer was yes (regularly eat 3 meals per day), and the score was 0 points if the answer was no. With the modified MSRA-5, using a cut-off points of less than or equal to 30 as a positive indicator for sarcopenia, the sensitivity increased to 86.2% and the AUC increased to 0.648. As the AWGS 2019 revises the diagnostic algorithm of the previous definition of sarcopenia and it does not include age in settings, we therefore also compared scores of MSRA-7, MSRA-5 and modified MSRA-5 questionnaires without Question 1 "How old are you?" with SARC-F to investigate sensitivity and diagnostic accuracy of sarcopenia. Aiming at the highest sensitivity to be a screening test, the best AUC with the highest sensitivity is still shown in modified MSRA-5 (Table 5).

Table 5
Analysis and AUCs for the Thai versions of SARC-F, MSRA-7, MSRA-5, and modified MSRA-5.

Tests	Sensitivity %	Specificity %	PPV %	NPV %	PLR (95% CI)	NLR (95% CI)	AUC (95% CI)
SARC-F	21.5	93.7	50	80.3	3.4 (1.7–6.8)	0.8 (0.7–1.0)	0.58
MSRA-7 (Original)	72.3	43.0	27.1	84.1	1.3 (1.1–1.5)	0.6 (0.4–1.0)	0.58
MSRA-7 (no original question 1)	50.8	67.0	31.1	82.2	1.5 (1.1–2.1)	0.7 (0.6–1.0)	0.59
MSRA-5 (Original)	61.5	67.4	35.7	85.7	1.9 (1.4–2.5)	0.6 (0.4–0.8)	0.65
MSRA-5 (no original question 1)	63.1	63.8	33.9	85.5	1.7 (1.4–2.3)	0.6 (0.4–0.8)	0.63
Modified MSRA-5	86.2	43.4	31.0	91.4	1.5 (1.3–1.8)	0.3 (0.2–0.6)	0.65
Modified MSRA-5 (no original question 1)	63.1	63.8	33.9	85.5	1.7 (1.4–2.3)	0.6 (0.4–0.8)	0.63

Values are presented as number (%).
SARC-F, Strength, Assistance with walking, Rise from a chair, Climb stairs and Falls; MSRA, The Mini Sarcopenia Risk Assessment; PPV, positive predictive value; NPV, negative predictive value; PLR, positive likelihood ratio; NLR, negative likelihood ratio; CI, confidence interval; AUC, area under receiver operating characteristic curve.

3.4. Associated factors for sarcopenia

Univariate logistic regression revealed that age 70–79 years old, age ≥ 80 years old, low BMI (<18.5 kg/m^2), medical history of dementia and osteoporosis, TMSE ≤ 23, polypharmacy (drugs ≥ 5/day), low physical activity (self-reported), and current smoker were significantly associated with sarcopenia. Currently working was a possible protective factor for sarcopenia. Multiple logistic regression analysis revealed that age ≥80 years old and low BMI (<18.5 kg/m^2) were associated factors of sarcopenia (Table 6).

4. Discussion

Our study indicated that MSRA-5 had less sensitivity diagnostic value than MSRA-7 (61.5% vs 72.3%). However, MSRA-5 exhibited only 5 items, which made it simpler than MSRA-7. We also found that the AUCs of MSRA-5 (0.65) were significantly larger than those of MSRA-7 and SARC-F (0.58 and 0.58, respectively). However, due to its relatively low sensitivity from our findings, MSRA-5 may be less appropriate for screening for sarcopenia in clinical practice. In order to increase the sensitivity of MSRA-5, we adjusted the least responded-to questions, ie, 2 and 4, from 0 to 15 points to 0–2 points. The modified MSRA-5 total points were changed from 60 points to 34 points. Then, we adjusted the cut-off points for the diagnosis of sarcopenia from 45 points or less to 30 points or less. The modified MSRA-5 had a higher sensitivity than the original MSRA-5 (86.2% vs 61.5%) and had acceptable specificity (43.4%). The AUCs of the modified MSRA-5 showed the same values as for the original MSRA-5 [0.65 (95% CI = 0.58–0.72) vs 0.65 (95% CI = 0.57–0.72)].

We found that the associated factors for sarcopenia were age ≥ 80 years old and a low BMI (<18.5 kg/m^2) when we analyzed the data using the multivariate logistic regression model. The factors were similar to those reported in previous studies [7,13–22]. Skeletal muscle mass and strength decline with age-related changes in biology [16]. The age-related loss of muscle mass is due to a decrease in myofiber size and number. The prevention and treatment of sarcopenia rely on the principle of non-pharmacological intervention [8,33]. The European Society of Clinical Nutrition and Metabolism guideline on clinical nutrition and hydration in geriatrics (ESPEN 2019) indicates that weight loss and inadequate nutrition are the important contributing factors of sarcopenia **[34]**. A combination of a balanced, nutrient-rich diet providing adequate energy and protein intake is well known for the prevention of muscle loss [34,35]. Both resistance and strengthening exercises have been shown to be successful interventions in the prevention and treatment of low muscle strength [36]. Though nutritional or exercise interventions and combined intervention variably affect sarcopenia, these are still recommended for the prevention and treatment of sarcopenia before the incidence of falls, dependency, or mortality occurs [36]. Being a current smoker in our study tended to be a risk factor of sarcopenia but it was not statically significant according to the multivariate analysis [OR = 13.22 (95% CI = 0.78–224.87)]. As mentioned above, smoking is an important risk factor for sarcopenia [13,22]. Structural and metabolic alterations were found in the muscle biopsies of smokers in comparison with non-smokers. In smokers, the muscle fibers cross-sectional area was decreased and lactate dehydrogenase (LDH) activity that indicated muscle damage was increased in smokers [37]. In their report on a one-year longitudinal study, Rom O et al. [38] indicated that muscle mass and muscle strength were increased among quitters when compared with continued smokers. However, that study was conducted in young participants (mean age 44 ± 12 years old), and further study should be conducted in older adults.

The prevalence of sarcopenia when using AWGS 2019 for the diagnosis of sarcopenia in a previous study by Kim M et al in South Korea in 2020 [39] was not much lower than in our study (21.3% vs

Table 6
Univariate and multivariate analyses for the associated factors of sarcopenia.

Variable	Univariate analysis odds ratio (95% CI)	P-value	Multivariate analysis odds ratio (95% CI)	P-value
Age, yr				
60–69	1.00		1.00	
70–79	2.34 (1.12–4.87)	0.02	1.87 (0.81–4.34)	0.14
≥ 80	10.71 (4.96–23.17)	< 0.001	5.92 (2.35–4.87)	< 0.001
BMI < 18.5 kg/m^2	11.71 (4.67–29.63)	< 0.001	9.59 (2.91–31.61)	< 0.001
Currently working	0.14 (0.04–0.46)	0.001	0.13 (0.03–0.66)	0.01
Medical history of				
Dementia	2.91 (1.45–5.84)	0.003	0.85 (0.32–2.28)	0.75
Osteoporosis	3.39 (1.32–8.75)	0.01	1.59 (0.5–5.08)	0.43
TMSE ≤ 23	3.24 (1.65–6.38)	0.001	1.95 (0.76–4.96)	0.16
Medication ≥ 5/day	1.82 (1.04–3.19)	0.04	1.11 (0.55–2.27)	0.77
Self-reported low physical activity	2.43 (1.37–4.33)	0.003	1.79 (0.87–3.67)	0.11
Current smoker	19.88 (2.26–174.74)	0.007	13.22 (0.78–224.87)	0.07

CI, confidence interval; BMI, body mass index; TMSE, Thai mental state examination.

24.4% in men and 13.8% vs 21.6% in women). Their study recruited the whole range of community-dwelling older adults, who were classified as those at risk of sarcopenia according to a low calf circumference, SARC-F questionnaire, and SARC-F plus calf circumference (SARC-Calf). The lower prevalence in that study may be due to the participants from the community who had less comorbidities and from false negative sarcopenia from those screening tools (calf circumference, SARC-F, and SARC-Calf). The prevalence of sarcopenia from an outpatient clinic was studied by Savas S et al in Turkey in 2019 [40]. They used the European working group on sarcopenia in older people (EWGSOP 2) [41] and regional cut-off values of muscle mass and handgrip strength for the diagnosis of sarcopenia. The prevalence of sarcopenia in their study was higher than in our study (41.1% vs 22.7%) because they used a skeletal muscle mass index (SMMI) instead of ASMI and used a higher regional cut-off SMMI (< 9.2 vs < 7 kg/m^2 in men and < 7.4 vs < 5.7 kg/m^2).

In Thailand, the prevalence of sarcopenia is not the same as in previous studies that reported a prevalence of 9.6% [6] and 30.5% [7]**.** This was probably caused by the different populations and the sarcopenia assessment method. The study by Promklang D et al [6] recruited participants from the community that are likely to be different from the participants in an outpatient clinic due to them having fewer comorbidities. The prevalence of sarcopenia reported by Khongsri N et al [7] was higher than in our study. This may be attributed to using whole-body muscle mass instead of limb mass, and as the BIA machine in their study used to measure muscle mass was a portable BIA system (Model 450 Biodynamics, Seattle, WA, USA), which does not measure appendicular skeletal muscle mass.

Some limitations of this study should be mentioned. Firstly, as convenience sampling was applied, selection bias may be present, resulting in an overrepresentation of healthier people as compared to other older patients in the outpatient clinic. Secondly, we studied the older patients from the general medicine outpatient where there was expected to be higher prevalence of sarcopenia. Therefore, the generalizability of the results to other settings should take this issue into consideration. Thirdly, some items were not suitable to older Thai population eg, questions about the consumption of milk or dairy products in MSRA-7 which is not common in Thai older people. Lastly, the test of this modified version of MSRA should be performed in second independent samples. This process is under ongoing study.

5. Conclusions

The SARC-F questionnaire was used to screen for sarcopenia according to AWGS 2019**,** but SARC-F alone was not adequate for screening for sarcopenia due to its low sensitivity; whereas MSRA-7 may provide better sensitivity in our study with limited specificity. MSRA-5 showed lower sensitivity than MSRA-7 but a higher specificity and AUC, whereas the modified MSRA-5 showed improved sensitivity and an improvement in the overall diagnostic accuracy for screening for sarcopenia. It would therefore be potentially useful for screening for sarcopenia in settings with limited resources of bioelectrical impedance analysis, limited time, or limited availability of health personnel. Further study is needed to test its use with a community-dwelling Thai older population.

CRediT author statement

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Conflicts of interest

The authors declare no competing interests.

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