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Original Study

SARC-F for Screening of Sarcopenia Among Older Adults: A Meta-analysis of Screening Test Accuracy

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A B S T R A C T

Objective: To examine the screening ability of SARC-F for older adults using a meta-analysis.
Design: Meta-analysis.
Setting and Participants: The literature review was conducted using MEDLINE, Cochrane Database of Systematic Reviews, and ClinicalTrials.gov. Articles written on and after 1960 that included data regarding the sensitivity and specificity of SARC-F's diagnostic criteria for sarcopenia in older adults were searched.
Measures: The bivariate random effects model was used to calculate the summary estimates of sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and diagnostic odds ratio (DOR). The summary receiver operating characteristic curve was used to summarize the overall test performance.
Results: Seven studies involving a total of 12,800 subjects met the eligibility criteria of our study. The pooled results of sensitivity, specificity, PLR, NLR, and DOR with the European Working Group on Sarcopenia in Older People as the reference standard were 0.21 [95% confidence interval (CI), 0.13-0.31], 0.90 (95% CI, 0.83-0.94), 2.16 (95% CI, 1.51-3.09), 0.87 (95% CI, 0.80-0.95), and 2.47 (95% CI, 1.64-3.74), respectively. Overall, we achieved similar pooled results of sensitivity and specificity for studies using the International Working Group on Sarcopenia and Asian Working Group for Sarcopenia as the reference standards. Because few studies used the Foundation National Institute of Health reference standards, a meta-analysis was not performed.
Conclusions/Implications: Although the screening sensitivity performance of SARC-F was poor, its specificity was high; thus, it is an effective tool for selecting subjects who should undergo further testing for confirming a diagnosis of sarcopenia.

The population of older adults is rising globally, with predominance in developed countries. Thus, growing attention has been given to sarcopenia, which is characterized by the decline of muscle mass, muscle strength, and physical functionality associated with aging.[1–3] The European Working Group on Sarcopenia in Older People (EWGSOP)[4] defines the diagnostic criteria of sarcopenia as follows: (1) low muscle mass, (2) low muscle strength, and (3) low physical performance. The International Working Group on Sarcopenia (IWGS),[5] the Asian Working Group for Sarcopenia (AWGS),[6] and the Foundation National Institute of Health (FNIH)[7] have similarly established their own diagnostic criteria for sarcopenia. Sarcopenia is also reportedly associated with a decline in activities of daily living and quality of life, death,[4] lowered cognitive function,[8] depression,[9] and increased medical costs,[10] thereby revealing the extremely high clinical importance of sarcopenia.

However, as described above, because the method of diagnosing sarcopenia is complex and is considered to be difficult to introduce into routine practice, more simplified methods of evaluation is warranted. Malmstrom and Morley created SARC-F, a simplified screening tool for assessing sarcopenia in older adults, and examined its validity.[11,12] SARC-F is a self-administered questionnaire used to determine the level of difficulty experienced for the 5 components of strength, assistance in walking, rise from a chair, climb stairs, and falls, with a 3-level score range of 0 to 2 points for each item, representing none (0), some (1), or a lot (2) [with the exception of falls, which is evaluated as none (0), 1-3 times (1), or ≥4 times (2)]. The total score

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range is 0 to 10, with scores of ≥4 points as the criteria for sarcopenia. There have been reports examining the screening ability of SARC-F in many countries since its creation,[13–18] which suggest a low sensitivity and high specificity of the SARC-F test despite some variance in the results. We believe that summarizing these previous studies will provide robust results regarding the screening ability of the SARC-F test. Therefore, the purpose of this study was to examine the screening ability of the SARC-F test on older adults by conducting a meta-analysis of previous studies.

Methods

Study Selection

The literature review consisted of a search of Medline, Cochrane Database of Systematic Reviews, and ClinicalTrials.gov on September 1, 2017, for articles written on or after 1960. Because the term "SARC-F" as an index test was considered very specific, it was assumed that the number of relevant articles would be few. To avoid search omissions, we included terms with wider meanings in addition to "SARC-F."[19] Therefore, the search strategy consisted of {"SARC-F" or [("elderly" or "aged" or "advanced age" or "old people") and ("screening" or "diagnosis" or "diagnostic" or "medical examination") and ("sarcopenia" or "muscle mass" or "fat free mass" or "European Working Group on Sarcopenia in Older People" or "Asia Working Group on Sarcopenia" or "International Working Group on Sarcopenia" or "Foundation National Institute of Health")]}. In addition, we used Google Scholar to include hand research (eg, conference minutes and letters to editors). We did not set a limit on language when researching. Studies with subjects aged ≥60 years containing data on the sensitivity and specificity of the SARC-F diagnostic criteria for sarcopenia for which a 2 × 2 table could be created were included. Two authors independently evaluated whether the results met the eligibility criteria of this study. When the 2 authors' opinions did not match, a third reviewer was consulted.

Data Extraction and Quality Assessment

We created a data extraction form that included the features of the study (key author's name; publication year; study location; sample size; patient's baseline information; cut-off points of SARC-F; reference standards for diagnosing sarcopenia; number of patients with sarcopenia using reference standards; and number of false positives, false negatives, true positives, and true negatives). Two authors independently evaluated the quality of the works included in this study. The quality was evaluated using the Quality Assessment of Diagnostic Accuracy Studies−2 (QUADAS-2).[20] The QUADAS-2 comprises 11 components divided into 4 domains of patient selection, index test, reference standard and flow, and timing and examines the risk of bias (high risk, low risk, and unclear risk) and applicability of each primary research by domain. The results were represented graphically.

Statistical Analysis

A bivariate random effects model was used to calculate summary estimates of sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and diagnostic odds ratio (DOR), and a summary receiver operating characteristic (SROC) curve was drawn.[21] The bivariate random effects model is said to correct index test thresholds (cut-off values) differences and inter-test variations (heterogeneity) of test accuracy.[21] Because meta-analyses must include at least 4 studies, we did not perform a meta-analysis in cases where there were fewer than 4 studies that met the criteria. As described earlier, there are several diagnostic criteria of sarcopenia that were used as reference standards (eg, EWGSOP); thus, it was predicted that the reference standard used in each study would differ. Because different reference standards yield variable test accuracy results of SARC-F,[20] meta-analyses were performed for each reference standard. We also assumed that the screening ability of SARC-F would be reported in terms of sex; however, because that would require us to exclude studies in which male and female results were reported together, we analyzed the results for both sexes together to assess the screening ability of SARC-F. For additional analysis, we excluded studies for which a QUADAS-2 domain of "high risk of bias" or "high applicability concerns" was reported. Furthermore, we created funnel plots to assess publication bias.[22] For analysis, we used RevMan version 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark; http://tech.cochrane.org/revman/download, August 2017) and Stata, version 12.1 (Stata Corp, College Station, TX).

Results

Description and Methodological Quality of Included Studies

A total of 2055 studies were extracted through the literary search, of which 7 studies (12,800 subjects) met the eligibility criteria for our study and were included in our meta-analysis (Figure 1).[13–18,23] The characteristics of the 7 studies are displayed in Table 1. The mean age of the patients was 75.1 years, and 61.8% of the subjects were females. The prevalence of sarcopenia was measured using the EWGSOP, IWGS, AWGS, and FNIH criteria, and the prevalence were 11.4%, 17.5%, 8.9%, and 3.0%, respectively.

The results of the evaluation of the quality of the studies included using QUADAS-2 are shown in Figure A1. In the majority of the studies included in our study, the index test and reference standard were unclear risks of bias, whereas patient selection and flow and timing were generally associated with a low risk of bias. On the other hand, in terms of applicability concerns, although patient selection (subjects with diabetes receiving outpatient treatment had different characteristics from community-dwelling older adults)[15] and the index test (use of a questionnaire used in a previous study rather than the use of the validity tested SARC-F[17]) demonstrated high applicability concerns, overall, the applicability concerns were low.

SROC Curve and Pooled Results

Figure 2 displays the SROC curve with EWGSOP as the reference standard. The ranges of SARC-F sensitivity and specificity in the

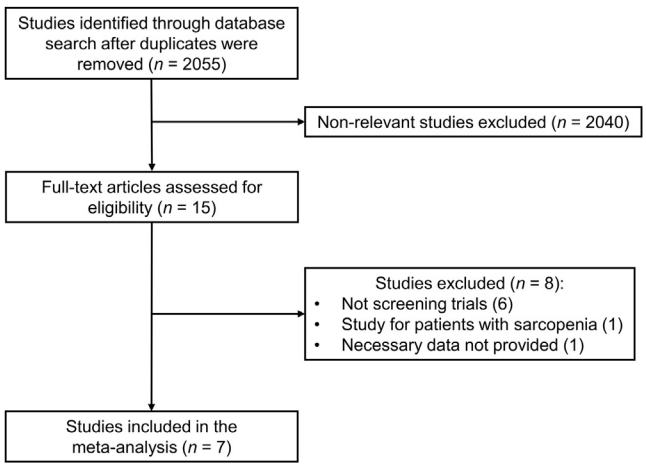

Fig. 1. Flow diagram of articles identified and evaluated during the study selection process.

Table 1
Summary of the Studies Included in the Meta-analysis

Studies	Year	Region	Study Population	No. of Patients	Age, y	Women, %	Cut-off Points of SARC-F	Reference Standard	Patients With Sarcopenia according to the EWGSOP Criteria, %	SARC-F and EWGSOP Sarcopenia Definitions			
										TP	FP	FN	TN
Woo J et al	2014	Hong Kong	Community-dwelling older adults	4000	73.5	49.9	4	EWGSOP, IWGS, AWGS	9	25	125	336	3501
Woo J et al	2015	Hong Kong	Community-dwelling older adults	4000	75	50	4	EWGSOP, IWGS, AWGS, FNIH	9	69	187	291	3452
Parra-Rodriguez L et al	2016	Mexico	Community-dwelling older adults	487	73.2	80.1	4	EWGSOP, IWGS, AWGS	9.3	16	79	29	360
Ida S et al	2016	Japan	Community hospital outpatient	207	71.7	39.1	4	EWGSOP	25.6	10	31	43	123
Barbosa-Silva TG et al	2016	Brazil	Community-dwelling older adults	179	≥60	61.4	6	EWGSOP	8.3	5	26	10	138
Rolland Y et al	2017	France	Community-dwelling older adults women	2705	80.5	100	4	FNIH	1.8*	17*	384*	32*	2272*
Kim S et al	2017	Korea	Community-dwelling older adults	1222	76.9	52.7	4	EWGSOP, IWGS, AWGS, FNIH	7.7	24	99	71	1028

FN, false negatives; FP, false positives; TN, true negatives; TP, true positives.

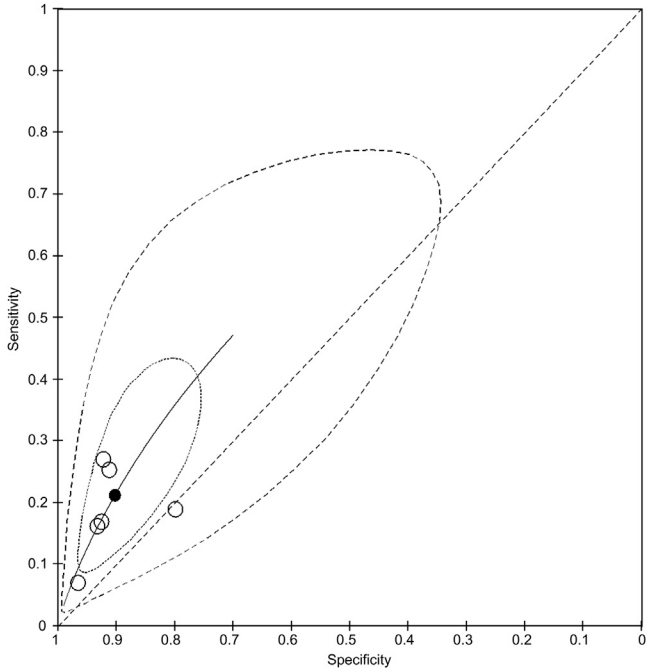

Fig. 2. Summary receiver operating characteristic (SROC) curve for SARC-F with European Working Group on Sarcopenia in Older People as the reference standard. Each solid circle represents each study in the meta-analysis. The confidence ellipse (short dashed line) indicates that the mean values for sensitivity and specificity were more likely to be in this region. The prediction ellipse (long dashed line) indicates that individual values for sensitivity and specificity were more likely to be in this region.

studies with EWGSOP as the reference standard[13–16,18,23] were 0.07 to 0.27 and 0.80 to 0.97, respectively (solid circle in Figure 2). The summary ROC curve represents the relationship between sensitivity and specificity across the included studies with a 95% confidence ellipse and a 95% prediction ellipse. The pooled results of sensitivity, specificity, PLR, NLR, and DOR with EWGSOP as the reference standard using the bivariate random effects model were 0.21 [95% confidence interval (CI), 0.13-0.31], 0.90 (95% CI, 0.83-0.94), 2.16 (95% CI, 1.51-3.09), 0.87 (95% CI, 0.80-0.95), and 2.47 (95% CI, 1.64-3.74), respectively (Table 2). The pooled results for the sensitivity and specificity with IWGS[13,14,18,23] and AWGS[13,14,18,23] as the reference standards were generally similar to the abovementioned findings. However, the pooled results of PLR (3.99, 95% CI, 1.72-8.89) and DOR (4.69, 95% CI, 1.84-11.92) with IWGS as the reference standard were somewhat higher compared with those of other reference standards. Because there were only 3 studies with FNIH as the reference standard,[17,18,23] these were omitted from the meta-analysis.

In an additional analysis performed after eliminating studies that were deemed to have high applicability concerns with QUADAS-2 using EWGSOP as the reference standard,[15,17] the pooled results of sensitivity, specificity, PLR, NLR, and DOR were 0.22 (95% CI, 0.12-0.36), 0.91 (95% CI, 0.85-0.95), 2.64 (95% CI, 2.00-3.48), 0.84 (95% CI, 0.75-0.94), and 3.11 (95% CI, 2.22-4.36), respectively. Furthermore, because only few studies were included in this study, we did not evaluate publication bias with funnel plots.

Discussion

This study demonstrated low sensitivity when EWGSOP, IWGS, AWGS, or FNIH was used as the reference standard, thereby indicating a low utility of SARC-F for the purpose of excluding sarcopenia. Its specificity however was very high, suggesting its high utility as a screening tool for selecting subjects who should undergo further

Table 2
Pooled Results of the Meta-analysis

Reference Standard	Sensitivity (95% CI)	Specificity (95% CI)	PLR (95% CI)	NLR (95% CI)	DOR (95% CI)
EWGSOP	0.21 (0.13-0.31)	0.90 (0.83-0.94)	2.16 (1.51-3.09)	0.87 (0.80-0.95)	2.47 (1.64-3.74)
IWGS	0.20 (0.10-0.38)	0.94 (0.88-0.97)	3.99 (1.72-8.89)	0.83 (0.70-0.98)	4.69 (1.84-11.92)
AWGS	0.14 (0.06-0.28)	0.93 (0.87-0.96)	2.13 (1.69-2.70)	0.91 (0.84-0.99)	2.32 (1.73-3.12)
FNIH	—	—	—	—	—

testing for confirming a diagnosis of sarcopenia. Among the results, the accuracy of SARC-F with IWGS as the reference standard was particularly high compared with the other reference standards. The results were approximately equal in an additional analysis, in which the studies evaluated as having a high risk of bias or high applicability concerns by QUADAS-2 were excluded.

The prevalence rates of sarcopenia in the studies included in this study by the reference standard used were 11.4%, 17.5%, 8.9%, and 3.0% for EWGSOP, IWGS, AWGS, and FNIH, respectively. The prevalence rates of sarcopenia in community-dwelling older adults reported in previous studies range between 5% and 13%,[24] which were generally similar to our results. Among the studies included in this study, the prevalence of sarcopenia was lower in the studies that used FNIH as the reference standard[17,18,23] and higher in the study of diabetic patients,[15] suggesting that the differences in the cut-offs of low muscle mass and differences between patient characteristics explained the variation in the prevalence rates of sarcopenia.

A SROC curve was drawn by deriving all the possible values of sensitivity and specificity of all the possible values that the threshold value may take, with sensitivity and 1 − specificity represented on the y and x axes, respectively. It shows the accuracy of the diagnostic text based on one index, allowing us to examine how the sensitivity and specificity changes depending on the threshold value. As we viewed this plot of primary research included on the ROC plane, we noticed that although there are studies that followed the SROC curve, there was a primary research that deviated from the curve. Although the dispersion of the primary research along the SROC curve is due to the threshold effect, those that fall at a greater distance from the SROC curve are believed to be due to factors other than the threshold effect.[25] Because a meta-analysis of screening abilities is likely to encompass the abovementioned threshold effect and heterogeneity in many cases,[25] we selected the bivariate random effects model, which estimates the test accuracy taking these effects into consideration. Because only few studies were included in this study, we did not conduct a subgroup analysis or explore the factors of heterogeneity with covariate hierarchical modeling. The reasons for the heterogeneity in our study may be due to the effects from differences in the study populations (eg, age and sex) or differences in understanding questionnaire items (nuance), which could be due to ethnic, social, or cultural differences translated from the original SARC-F version.

In the pooled results of the study, the SARC-F sensitivity was low and its specificity was high, regardless of the reference standards. Furthermore, PLR and NLR of the reference standards were 2.13 to 3.99 and 0.83 to 0.91, respectively. The higher the PLR and the more positive the test results, the more likely it is for the actual status to be positive, leading to a definitive diagnosis.[26] Conversely, the lower the PLR and the more negative the test results, the more likely it is for the actual status to be negative, thereby leading to diagnosis by exclusion. The NLR results of our study were high regardless of reference standards, thereby suggesting that it could not be suitably used for “ruling out.” In contrast, PLR was relatively high when IWGS was used as the reference standard, indicating that it could be used more appropriately for “ruling in,” in comparison to using other reference standards. Finally, DOR when IWGS was used as the reference standard was higher compared to when other reference standards were used. DOR is found by dividing PLR by NLR and represents the screening ability of one indicator. DOR can range between 0 and ∞, and a higher DOR represents a higher accuracy.[26] Although careful attention should be paid to the fact that there could be multiple omissions when SARC-F is used for excluding sarcopenia as a result of pooled results of sensitivity, specificity, PLR, NLR, or DOR, it suggests that people positive for SARC-F were highly likely to have sarcopenia. Furthermore, these test accuracies were believed to be particularly high when the reference standard was IWGS.

Sarcopenia was added to the International Classification of Diseases code in October 2016. Therefore, we can predict that there will be increased opportunities to diagnose and treat sarcopenia in the future. Sarcopenia has been associated with poor outcomes (eg, future falls, lowered physical function, death, and increased medical costs).[4,9,10] Therefore, clinically, it is considered very important to diagnose sarcopenia. As mentioned earlier, however, diagnosis of sarcopenia is often accompanied with challenges as it requires expensive equipment to measure muscle mass and perform an assessment of grip strength and physical function. SARC-F is highly feasible because it is a self-administered questionnaire that enables a simple assessment. It is important for this screening tool to be simple and low-cost, not require a specially trained tester, and have short administration times.[27] By narrowing down individuals with a higher likelihood of sarcopenia using SARC-F, the amount of time taken to assess muscle mass, grip strength, and physical performance, which are necessary for the eventual definitive diagnosis, can be reduced. In addition, previous reports have noted that those diagnosed with sarcopenia using SARC-F are strongly associated with declined physical performance, quality of life, and death[23] and hospitalization.[28] The fact that positive sarcopenia screened using SARC-F is associated with clinically important outcomes also suggests the effectiveness of SARC-F. Treatment for sarcopenia includes resistance exercises, protein intake,[29–31] and drug therapy to improve sarcopenia symptoms.[32,33] Because sarcopenia is treatable,[34] it is important to make an early diagnosis and rapidly implement treatment measures for sarcopenia; thus, SARC-F is useful for accomplishing this goal.

There are several limitations associated with this study: (1) There are relatively few studies included in this study, and their heterogeneity is suspected, which may have affected the validity of the results. In particular, we could not obtain pooled results of the studies with FNIH as the reference standard because of a limited number of studies. (2) We cannot deny that there may have been studies that met the eligibility criteria in databases that we did not use this time, which may have impacted the results. And (3) there were multiple studies included in the quality of this study with “unclear risks of bias” in index tests and reference standards. These biases may overestimate screening abilities,[20] thereby suggesting possible concerns over validity of our results.

In conclusion, the screening ability of SARC-F appears to be low for the purpose of excluding sarcopenia; however, it could represent a very useful tool for detecting subjects for further testing to make a definitive diagnosis of sarcopenia. Despite the above limitations, considering the clinical importance of sarcopenia and the ease of running the screening test, SARC-F represents a very useful tool.

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Supplementary Data

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.jamda.2018.04.001.

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