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SARC-F for sarcopenia screening in community-dwelling older adults
Are 3 items enough?

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Abstract

A 3-item SARC-F (termed SARC-F-3 in our study) was recently suggested as a screening tool for sarcopenia.

The aim of this study was to compare the diagnostic value of SARC-F-3 to SARC-F in community-dwelling older people.

We conducted a diagnostic accuracy study in an urban community in Chengdu, China. People aged 60 years or older were included. Muscle mass, strength, and physical performance were measured by a bio-impedance analysis (BIA) device, handgrip strength, and gait speed test, respectively. The Asia Working Group for Sarcopenia (AWGS) criteria were applied as the "gold reference." The sensitivity/specificity analyses of SARC-F and SARC-F-3 were performed. The receiver operating characteristic (ROC) curve and area under the ROC curve (AUC) were applied to compare the overall accuracy of SARC-F and SARC-F-3. The cut-off points of SARC-F-3 for sarcopenia were determined using the Youden index method.

A total of 384 older people aged 71.5 ± 5.8 years were included. On the basis of the AWGS criteria, the prevalence of sarcopenia in our study population was 15.9%. The optimal cut-off point of SARC-F-3 for identifying sarcopenia was a total score of ≥ 2. In the whole study population, the sensitivity and specificity of SARC-F were 29.5% [95% confidence interval (95% CI): 18.5–42.6] and 98.1% (95% CI: 96.0–99.3), respectively, whereas the sensitivity and specificity of SARC-F-3 were 13.1% (95% CI: 5.8–24.2) and 97.8% (95% CI: 95.6–99.1), respectively. The AUCs of SARC-F and SARC-F-3 were 0.894 (95% CI: 0.859–0.923) and 0.676 (95% CI: 0.627–0.723), respectively ($P < .001$).

The 3-item SARC-F may not be suitable for screening sarcopenia in community-dwelling older people.

Abbreviations: ASM = appendicular skeletal muscle mass, AUC = area under the ROC curve, AWGS = Asia Working Group for Sarcopenia, BIA = bio-impedance analysis, BMI = body mass index, CI = confidence interval, COPD = chronic obstructive pulmonary disease, CT = computed tomography, DXA = dual-energy X-ray absorptiometry, EWGSOP = European Working Group on Sarcopenia in Older People, GS = gait speed, HS = handgrip strength, IQR = interquartile range, MRI = magnetic resonance imaging, MSRA = Mini Sarcopenia Risk Assessment, NLR = negative likelihood ratio, PLR = positive likelihood ratio, ROC = receiver operating characteristics, SD = standard deviation, SMI = skeletal muscle mass index.

Keywords: older adults, sarcopenia, screening, sensitivity, specificity

1. Introduction

Sarcopenia is a geriatric syndrome characterized by age-related loss of skeletal muscle mass, strength, and physical performance.[1] In the past decade, numerous studies have been conducted to address the impact of sarcopenia on various health outcomes, such as risk of falls, poor quality of life, and mortality, in not only older adults but also in patients with cancer,[2] diabetes,[3] and other chronic diseases.[4] However, one of the most critical issues in the field of sarcopenia research is the diagnosis of sarcopenia per se.[5]

There are currently at least 6 international groups that have published consensus diagnostic criteria for sarcopenia.[5] All these groups agree that low muscle mass, low muscle strength, and/or low physical performance are needed to diagnose sarcopenia.[5] However, the agreement of the cut-off points for each component of sarcopenia has not been reached. In addition, special medical devices, such as computed tomography (CT), magnetic resonance imaging (MRI), dual-energy X-ray analysis (DXA), or bio-impedance analysis (BIA), are required for the diagnosis of sarcopenia.[5,6] These issues may contribute to the underdiagnosis of sarcopenia in clinical practice.

SARC-F and SARC-F-3 questionnaires.

Components	Questions	SARC-F score	SARC-F-3 score
Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0 Some = 1 A lot or unable = 2	None = 0 Some = 1 A lot or unable = 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	None = 0 Some = 1 A lot, use aids, or unable = 2
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	-
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2	-

Several sarcopenia screening tools have been developed to resolve this problem. As a pioneer of these tools, the SARC-F has been validated in various studies and translated into different languages, such as Chinese,[7] Japanese,[8] Spanish,[9] and Korea.[10] The SARC-F has 5 items: strength, assistance in walking, rising from a chair, climbing stairs, and falls (Table 1).[11]

Recently, on the basis of a study population of 4000 community-dwelling adults, Woo et al[12] argued that the SARC-F may be shortened to 3 items (including strength, climbing stairs, and assistance in walking) (Table 1). Compared with SARC-F, this 3-item SARC-F (termed SARC-F-3 in our study) is shorter and therefore more rapid for sarcopenia screening. However, it is not clear whether SARC-F-3 is valid for estimating sarcopenia. We, therefore, conducted a study to compare the diagnostic value of SARC-F-3 to SARC-F in a study population of community-dwelling older adults.

2. Methods

2.1. Study design and population

From October to November 2017, a cross-sectional study was conducted in Chengdu, China. Older adults (aged 60 years or older) living in an urban community were included consecutively. The study participants were recruited through posters and WeChat (the most popular social media app in China). The exclusion criteria included subjects with any of the following conditions: severe mental illnesses (defined as a medical history of psychotic disorders, bipolar disorders, or major depression); implanted pacemaker; visible edema; unable to walk; severe renal failure (defined as an estimated glomerular filtration rate <30 mL/min/1.73 m^2 in the last 6 months); severe heart failure (defined as NYHA class III or IV); and unable to communicate with interviewers. Informed consent forms were signed by participants or their legal proxies. The study protocol was approved by the Research Ethics Committee of Sichuan University (Research ID: 2017–083).

2.2. Measurements of muscle mass, strength, and physical performance

According to the recommendation of the Asia Working Group for Sarcopenia (AWGS),[13] we applied a BIA device (InBody 230;

Biospace Co. Ltd., Seoul, Korea) to estimate the appendicular skeletal muscle mass (ASM). To measure the ASM, the individuals were asked to stand upright with their hands on the handles and their bare feet on the footpads of the BIA device. Next, the skeletal muscle mass index (SMI) was calculated using the equation SMI (kg/m^2) = ASM/height^2.

We measured handgrip strength (HS) to estimate muscle strength. We applied a handheld dynamometer based on strain gauge sensors (EH101; Xiangshan Inc., Guangdong, China) to measure the HS of all participants. To measure the HS, the individuals were asked to seat with the elbow flexed at a 110° angle, the wrist placed in a neutral position, and the interphalangeal joint of the index finger positioned at a 90° angle.[14] Three readings were obtained from each hand, and the highest value was recorded.

In addition, we measured gait speed (GS) to estimate the physical performance. To assess the GS, the participants were asked to walk 4 m from a standing start at their usual walking speed. Canes or walkers were acceptable, if necessary. All these tests were performed by trained nurses.

2.3. Assessment of sarcopenia

In this study, the AWGS criteria were applied as the "gold reference." The AWGS criteria are as follows: low muscle mass: SMI <7.0 kg/m^2 for men; and SMI <5.7 kg/m^2 for women; low muscle strength: HS <26 kg for men; and HS <18 kg for women; and low physical performance: GS <0.8 m/s for men and women. Subjects who met all 3 criteria were considered to have sarcopenia.[13]

In addition, all participants were tested using the SARC-F and SARC-F-3 through a face-to-face interview performed by trained nurses. For SARC-F, a total score of ≥ 4 indicates sarcopenia.[11] For SARC-F-3, the cut-off points of the total score for identifying sarcopenia have not been established. We, therefore, applied the Youden index method to determine the optimal cut-off point. For each participant, the interview and the measurements of muscle mass, strength, and physical performance were performed on the same day.

2.4. Covariates

Trained nurses collected the following covariates through face-to-face interviews: age, gender, and the medical history of the

following chronic diseases: hypertension, diabetes, coronary heart disease, chronic obstructive pulmonary disease, and stroke. Trained nurses also measured body weight and height. The body mass index (BMI) was then calculated using the equation: BMI (kg/m^2) = body weight/ height^2.

2.5. Statistical analyses

All statistical analyses in this study were performed in MedCalc Statistical Software version 15.2 (MedCalc Software bvba, Ostend, Belgium). A P value of $<$ .05 indicates statistical significance.

The results were presented as the number (percentage), mean [standard deviation (SD)], and median [interquartile range (IQR)] for categorical variables, continuous variables with normal distribution, and continuous variables with skewed distribution, respectively. To compare the differences between groups, the χ^2 test, 1-way analysis of variance (ANOVA) test, and Mann–Whitney test were applied for categorical variables, continuous variables with normal distribution, and continuous variables with skewed distribution, respectively.

Using the AWGS criteria as the "gold reference," the sensitivity, specificity, positive likelihood ratio (PLR), and negative likelihood ratio (NLR) of the SARC-F and SARC-F-3 for identifying sarcopenia were calculated, respectively. The receiver operating characteristics (ROC) curves and the area under the ROC curve (AUC) were applied to compare the overall diagnostic accuracy of the SARC-F and SARC-F-3. A larger AUC indicates a better overall diagnostic accuracy.[15] We applied the DeLong method [16] to calculate the 95% confidence intervals (95% CIs) for the AUC and the comparisons between ROC curves. We applied the Youden index method to determine the optimal cut-off point of SARC-F-3 for identifying sarcopenia

because it does not require other information (e.g., decision error costs).[17] We estimated the sample size required to achieve 0.8 power to detect the difference between the ROC curves using the "sample size: comparison of ROC curves" function in MedCalc Statistical Software 15.2. The estimated sample size was 280 (including 40 individuals with sarcopenia and 240 participants without sarcopenia).

In addition, the overlap of the 3 definitions of sarcopenia was shown using a Venn diagram. Due to the gender difference of sarcopenia,[18] we also performed subgroup analyses based on gender.

3. Results

Figure 1 shows the flow diagram of our study. A total of 384 older adults aged 71.5 ± 5.8 years were included. On the basis of the AWGS criteria, the prevalence of sarcopenia in our study population was 15.9% (men: 11.9%; women 18.8%, $P = .069$). Using the SARC-F, the prevalence of sarcopenia was 12.2% (men: 9.4%; women: 14.3%, $P = .148$). Using SARC-F-3, the prevalence of sarcopenia was 13.3% (men: 8.1%, women: 17.0, $P = .012$) (Table 2). Figure 2 shows the overlap of the 3 criteria of sarcopenia. Only 9 participants were identified as sarcopenia at the same time by all 3 criteria.

Table 3 presents the sensitivity/specificity analyses and ROC models for SARC-F and SARC-F-3 validation against the AWGS criteria. Using the Youden index method, the optimal cut-off points of SARC-F-3 for identifying sarcopenia in the whole study population were a total score of ≥ 2 (Youden index = 0.109). In both men and women, the cut-off points of SARC-F-3 were also a total score of ≥ 2 (Youden index = 0.045 and 0.113, respectively).

In the whole study population, the sensitivity and specificity of SARC-F were 29.5% (95% CI: 18.5–42.6) and 98.1% (95% CI:
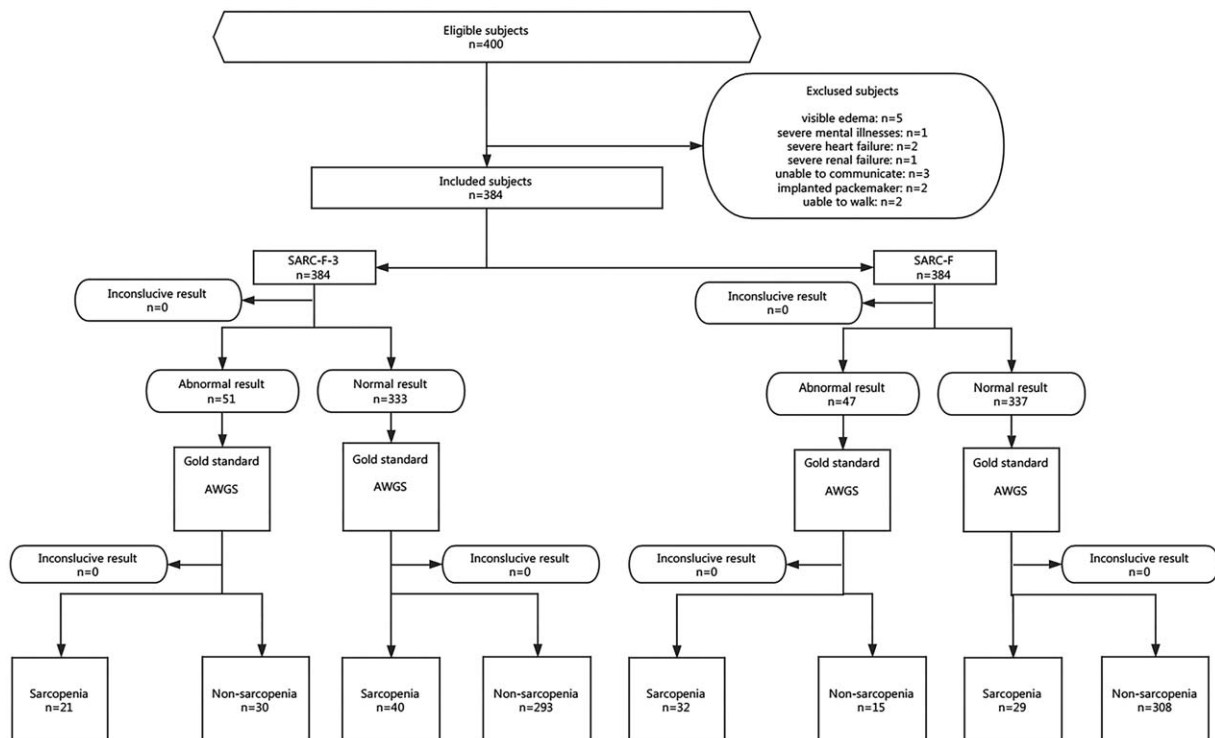

Figure 1. The flow diagram of this study.

Table 2

Characteristics of the study population by gender.

Characteristics	Total (n = 384)	Men (n = 160)	Women (n = 224)	P
Age, y[†]	71.5 (5.8)	72.3 (6.0)	70.9 (5.5)	.022
BMI, kg/m^2[†]	24.2 (3.3)	24.1 (3.3)	24.3 (3.3)	.715
GS, m/s[†]	0.9 (0.2)	0.9 (0.3)	0.9 (0.2)	.009
HS, kg[†]	22.9 (8.9)	29.4 (8.9)	18.3 (5.4)	<.001
ASM, kg[†]	14.9 (3.8)	18.2 (3.0)	12.6 (2.2)	<.001
Comorbidities[*]				
Hypertension	116 (30.2)	50 (31.3)	66 (29.5)	.707
Coronary heart disease	36 (9.4)	12 (7.5)	24 (10.7)	.287
Diabetes	36 (9.4)	15 (9.4)	21 (9.4)	1.000
Stroke	47 (12.2)	14 (8.8)	33 (14.7)	.078
COPD	32 (8.3)	14 (8.8)	18 (8.0)	.803
SARC-F score [‡]	0 (2.0)	0 (1.0)	1.0 (2.0)	<.001
SARC-F-3 score [‡]	0 (1.0)	0 (0.0)	0 (1.0)	<.001
SARC-F classification[*]				
Non-sarcopenia	337 (87.8)	145 (90.6)	192 (85.7)	
Sarcopenia	47 (12.2)	15 (9.4)	32 (14.3)	.148
SARC-F-3 classification[*]				
Non-sarcopenia	333 (86.7)	147 (83.0)	186 (83.0)	
Sarcopenia	51 (13.3)	13 (8.1)	38 (17.0)	.012
AWGS classification[*]				
Non-sarcopenia	323 (84.1)	141 (88.1)	182 (81.3)	
Sarcopenia	61 (15.9)	19 (11.9)	42 (18.8)	.069

[*] Data are presented as n (%).
[†] Data are presented as the mean (standard deviation).
[‡] Data are presented as the median (interquartile range).
ASM = appendicular skeletal muscle mass, AWGS = Asia Working Group for Sarcopenia, BMI = body mass index, COPD = chronic obstructive pulmonary disease, GS = gait speed, HS = handgrip strength.

96.0–99.3), respectively, whereas the sensitivity and specificity of SARC-F-3 were 13.1% (95% CI: 5.8–24.2) and 97.8% (95% CI: 95.6–99.1), respectively. The ROC curves of SARC-F and SARC-F-3 against the AWGS criteria are shown in Fig. 3. The AUCs of SARC-F and SARC-F-3 were 0.894 (95% CI: 0.859–0.923) and 0.676 (95% CI: 0.627–0.723), respectively ($P < .001$).

The subgroup analyses showed similar results in both men and women (Table 3 and Fig. 3).

4. Discussion

In our study population of community-dwelling older adults, both SARC-F and SARC-F-3 showed a low sensitivity and a high specificity when using the AWGS criteria as the "gold reference." However, SARC-F had significantly better sensitivity and overall diagnostic accuracy than SARC-F-3. There was a little overlap of sarcopenia defined by SARC-F, SARC-F-3, and AWGS, respectively.

Our study found that the sensitivity of the SARC-F was very low (13.1% in the whole study population). This finding was in accordance with previous studies.[9,11,19] For example, on the basis of a study population of 4000 participants and using the European Working Group on Sarcopenia in Older People (EWGSOP) criteria as the "gold reference," Woo et al[20] reported that SARC-F had a sensitivity of 4.2% in women and 9.9% in women. Another study reported that SARC-F had a sensitivity of 35.6% and a specificity of 82.2% against the EWGSOP criteria in 487 Mexican community-dwelling older adults.[9]
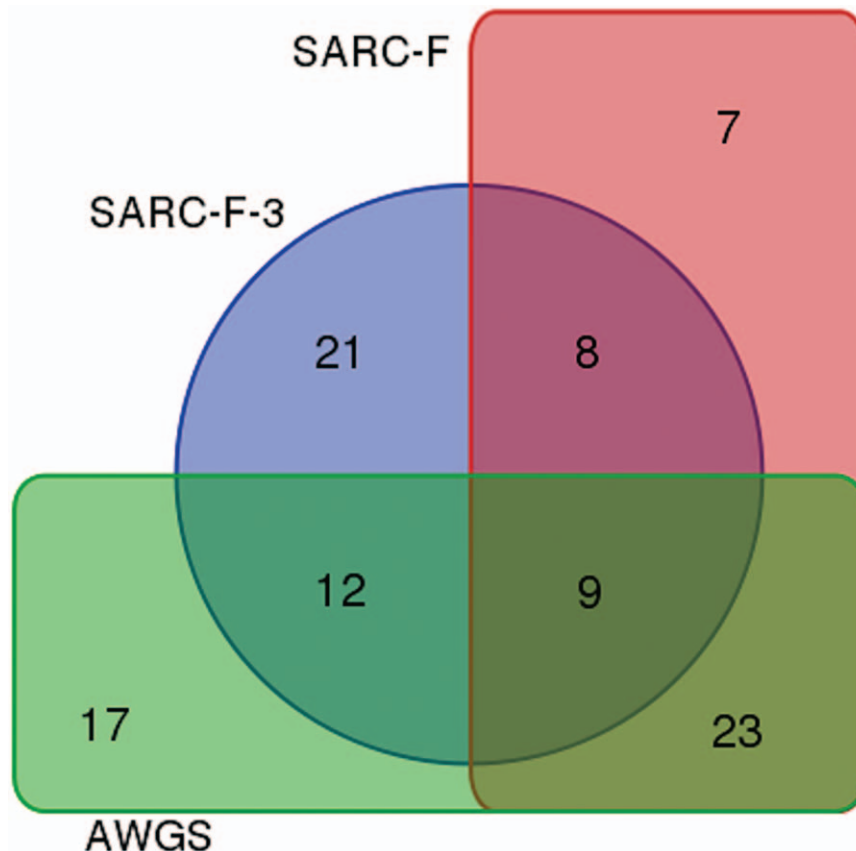

Figure 2. Number of participants identified as having sarcopenia according to different criteria.

Table 3

Sensitivity/Specificity analyses and ROC models for SARC-F and SARC-F-3 validation against the AWGS criteria*.

	Sensitivity (%)	Specificity (%)	PLR	NLR	AUC	*P*
Total						
SARC-F	29.5 (18.5–42.6)	98.1 (96.0–99.3)	15.9 (6.6–38.4)	0.7 (0.6–0.8)	0.894 (0.859–0.923)	<.001
SARC-F-3	13.1 (5.8–24.2)	97.8 (95.6–99.1)	6.1 (2.3–16.1)	0.9 (0.9–1.0)	0.676 (0.627–0.723)	
Men						
SARC-F	15.8 (3.4–39.6)	97.8 (93.9–99.6)	7.4 (1.6–34.2)	0.8 (0.7–1.0)	0.859 (0.795–0.909)	.007
SARC-F-3	5.3 (0.1–26.0)	99.2 (96.1–100.0)	7.4 (0.5–113.8)	1.0 (0.9–1.1)	0.659 (0.580–0.732)	
Women						
SARC-F	35.7 (21.6–52.0)	98.3 (95.3–99.7)	21.7 (6.6–71.5)	0.7 (0.5–0.8)	0.909 (0.864–0.943)	<.001
SARC-F-3	16.7 (7.0–31.4)	96.7 (93.0–98.8)	13.0 (1.4–121.9)	0.9 (0.9–1.0)	0.670 (0.604–0.731)	

Data are presented as 95% confidential interval in parenthesis.
AUC = area under the curve, AWGS = Asia Working Group for Sarcopenia, NLR = negative likelihood ratio, PLR = positive likelihood ratio, ROC = receiver operating curves.
* The cut-off points for SARC-F and SARC-F-3 are the total score of each scale ≥ 4 and ≥ 2, respectively.

We found that SARC-F-3 had even lower sensitivity and overall diagnostic accuracy than SARC-F. A low sensitivity implies the possibility of omitting subjects who do have sarcopenia. On the contrary, an AUC of > 0.9 indicates high accuracy, 0.7 to 0.9 indicates moderate accuracy, 0.5 to 0.7 indicates low accuracy, and 0.5 indicates chance result.[15] In our study, the AUC of SARC-F was 0.894, whereas that of SARC-F-3 was 0.676. Therefore, SARC-F-3 may not be suitable for sarcopenia screening in community-dwelling older adults.

Recently, Barbosa-Silva et al[21] reported that combining calf circumference (CC) with SARC-F (named SARC-CalF) can significantly improve the sensitivity of SARC-F from 33.3% (95% CI 11.8–61.6) to 66.7% (95% CI 38.4–88.2) and overall diagnostic accuracy (AUCs = 0.736 vs 0.592, respectively; $P=.027$), but it does not compromise its specificity. Moreover, Urzi et al[22] reported that the SARC-CalF had a sensitivity of 77.4% and a specificity of 89.8% in 80 nursing home residents when using the EWGSOP criteria as the "gold reference." These findings imply that SARC-CalF, compared with SARC-F, may be a more suitable screening tool for sarcopenia in clinical practice; however, further studies are needed before a robust conclusion can be drawn.

In addition, a new screening tool for sarcopenia named the Mini Sarcopenia Risk Assessment (MSRA) has been developed.[23] The MSRA has 2 versions: the full version (MSRA-7, including 7 items) and the short version (MSRA-5, including 5 items). Using the EWGSOP criteria as the "gold reference," MSRA-5 had a sensitivity of 80.4% and a specificity of 60.4% for identifying sarcopenia, whereas MSRA-7 had a sensitivity of

80.4% and a specificity of 50.5%.[23] Therefore, MSRA-5 may serve as an alternative for sarcopenia screening tools. It would be interesting to make a head-to-head comparison of MSRA, SARC-F, and SARC-CalF in various settings.

Our study has some limitations. First, we applied BIA instead of the "gold" methods (CT, MRI, or DXA) to estimate skeletal muscle mass. The accuracy of BIA for estimating muscle mass is controversial.[24] However, BIA is more practicable for community-dwelling people and is inexpensive and free of X-ray exposure. In addition, BIA is also recommended as an alternative for assessing muscle mass by the AWGS criteria.[13] Second, we only included older adults living in an urban community. Therefore, our results may not represent those living in rural or semirural areas. Third, this study is a cross-sectional design. Therefore, we could not compare the predictive validities of SARC-F and SARC-F-3.

5. Conclusion

The 3-item SARC-F (SARC-F-3) may not be suitable for screening sarcopenia in community-dwelling older adults, considering it has a significantly lower overall diagnostic accuracy and sensitivity than SARC-F.

Author contributions

Conceptualization: Ming Yang, Xiaoyi Hu.
Data curation: Ming Yang, Xiaoyi Hu, Lingling Xie, Jing Lin.
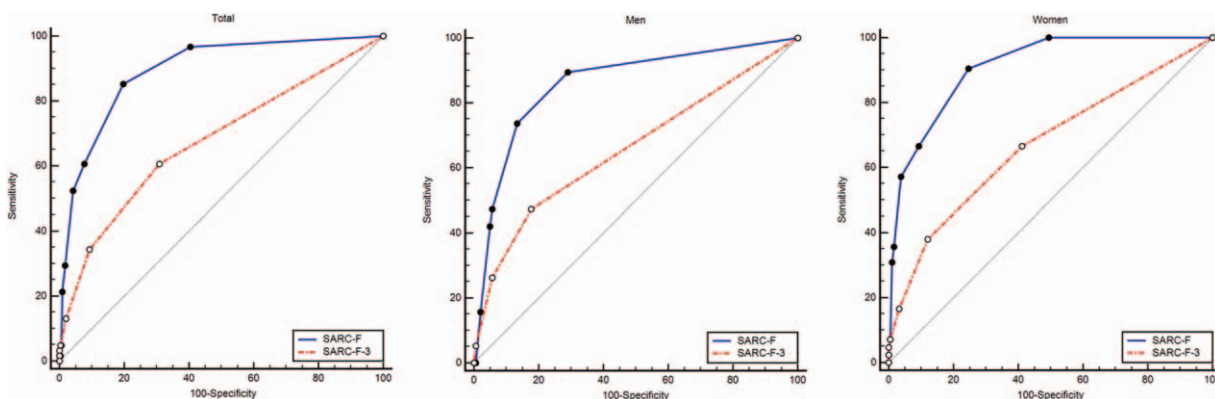**Formal analysis:** Ming Yang, Xiaoyi Hu, Lingling Xie.

Figure 3. The ROC curves of SARC-F and SARC-F-3 against the AWGS criteria.

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