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PERFORMANCE OF SARC-F IN REGARD TO SARCOPENIA DEFINITIONS, MUSCLE MASS AND FUNCTIONAL MEASURES

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Abstract: *Objective:* To assess the reliability and validity of Turkish version of SARC-F in regard to screening with current definitions of sarcopenia, muscle mass and functional measures. *Design:* Cross-sectional study. *Participants:* Community-dwelling older adults aged >=65 years admitting to a geriatric outpatient clinic. *Measurements:* Muscle mass (bioimpedance analysis), handgrip strength, usual gait speed, chair sit-to-stand test, functional reach test, short physical performance battery, SARC-F questionnaire, FRAIL questionnaire Sarcopenia was evaluated with 4 current different definitions: European Working Group on Sarcopenia in Older People's (EWGSOP); Foundation for the National Institutes of Health (FNIH), International Working Group on Sarcopenia (IWGS) and Society on Sarcopenia, Cachexia and Wasting Disorders (SCWD). *Results:* After cross-cultural adaptation, 207 subjects were analysed in the clinical validation study. Mean age was 74.6±6.7 years, 67.6% were women. Against EWGSOP, FNIH, IWGS and SCWD definitions of sarcopenia, sensitivity of SARC-F were %25, 31.6%, 50% and 40%; specificity were 81.4%, 82.4%, 81.8% and 81.7%, respectively. Positive predictive values were between 5.1-15.4% and negative predictive values were 92.3-98.2%. Against parameters of low muscle mass, sensitivity were about 20% and specificity were about 81%. Against parameters of function; for low hand grip strength, sensitivity of SARC-F were 33.7% (for Turkish cut-off); 50% (for FNIH cut-off); specificity were 93.7% (for Turkish cut-off) and 85.8% (for FNIH cut-off). Against low UGS, poor performance in chair sit to stand test, functional reach test, SPPB and presence of positive frailty screening sensitivity were 58.3%, 39.2%, 59.1%, 55.2% and 52.1% while specificity were 97.3%, 97.8%, 88.1%, 99.3% and 91.2%, respectively. *Conclusion:* The psychometric performance of Turkish SARC-F was similar to the original SARC-F. It revealed low sensitivity but high specificity with all sarcopenia definitions. Sensitivity and specificity were higher for muscle function tests reflecting its inquiry and input on functional measures. Our findings suggest that SARC-F is an excellent test to exclude muscle function impairment and sarcopenia. SARC-F is relatively a good screening test for functional measures.

Key words: Sarcopenia, SARC-F, screening, validation, muscle mass, function, sensitivity, specificity.

Introduction

Sarcopenia is age related loss of skeletal muscle mass. It is a prevalent geriatric syndrome coupled with functional detoriation, dependency, falls, frailty and mortality. Its prevalence and impact increase by ageing and global ageing of the population thereby transformed sarcopenia to a public health problem of major priority (1). Many researches have been conveyed and being conveyed to put forward measures for its preventive and therapeutic management (2). It is expected that early and timely identification of sarcopenia may aid to decrease negative outcomes with commencement of preventive and therapeutic measures.

Assessment of sarcopenia needs measurement instruments for objective evaluation of muscle mass and function that also requires substantial dedicated time. Hence, screening of sarcopenia with user friendly, simple tools are required (3). Screening positive subjects may then be referred to health professionals to undergo full assessment. SARC-F is a very practical tool that is presented at 2013 (4).

In longitudinal studies, it has been demonstrated to predict the adverse consequences associated with sarcopenia (4). It may be suggested as one of the best tools that can effectively be used to screen sarcopenia in every day practice (4). SARC-F is originally presented in English. To date its cultural adaptation and clinical validation were performed in 6 languages (Mexican Spanish, Japanese, Brazilian Portuguese, German, French and Korean (5-10). SARC-F questions functional measures i.e strength, assistance in walking, rise from a chair; climb stairs and falls. In all of the validation studies SARC-F proved relatively low sensitivity and high specificity reflecting its high potential to exclude sarcopenia but lower efficacy in detecting it. Current definitions of sarcopenia includes co-presence of low muscle mass and muscle function and low muscle mass is the prerequisite for sarcopenia diagnosis. SARC-F has no inquiry on the subjective or objective measures of muscle mass. Thus it is not surprising that SARC-F exhibited low sensitivity for sarcopenia diagnosis. We suggest that SARC-F will have higher sensitivity to detect poor muscle function and may be an efficient screening test for functional measures while it would have lower sensitivity to detect low muscle mass (LMM). In this study, we aimed to study the reliability and validity of Turkish version of SARC-F in regard to current definitions of sarcopenia, muscle mass measures and a variety of objective

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functional parameters. We also studied the associations between sarcopenia screening by SARC-F and frailty screening by FRAIL tools.

Material and Methods

The validation process was performed as depicted by the methodological report from European Union Geriatric Medicine Society (EUGMS) Sarcopenia Special Interest Group (SIG) (3). First phase constituted the translation with cross-cultural adaptation of SARC-F in Turkish. Second phase constituted the clinical validation study.

First phase (Translation and cross cultural adaptation)

As suggested by the EUGMS SIG paper, this phase was composed of eight different steps that were in general based on the guidelines put forward by the World Health Organization (11). An expert panel comprising two bilingual experts, with one having Turkish as mother tongue and one having English as mother tongue, and two other geriatrician bilingual experts were organized. At step 1, the English SARC-F was translated to Turkish by one bilingual expert to obtain the translated SARC-F version 1. At step 2, an expert panel composed of two geriatrician bilingual experts reviewed the translation and discussed the conceptual adequacy and clarity of the translation and agreed on the translated SARC-F version 2. During step 3, version 2 was back-translated from Turkish to English by a bilingual translator having English as their mother tongue and blinded to the original version of the questionnaire. At step 4, the two translators and the two geriatrician experts reviewed all the translated versions and the original SARC-F in English to reach a consensus, a satisfactory Turkish SARC-F version 3. Version 3 and the backward version was e-mailed, at step 5, to John Morley, as one of the authors of the original English SARC-F and was approved. At step 6, the Turkish SARC-F was administered face-to-face to five male and five female older adults as a pre-test to reveal their doubts and suggestions regarding comprehension and cultural relevance of the questionnaire. These ten participants were free of acute conditions affecting their functionality and did not have significant cognitive problems hindering their comprehension of the questionnaire. As step 7, the SARC-F questionnaire was administered to 20 other subjects by two different geriatricians to assess inter-rater reliability. At the final step, the SARC-F was applied by phone or face-to-face to these 20 participants to evaluate test–retest reliability.

Second phase (Clinical validation)

Community-dwelling subjects >= 65 years that were able to walk independently and understand the aim of the study were included. The minimum required number of subjects were between 50- 100 community-dwelling older adults >=65 years of age. Clinical validation was performed to assess specificity and sensitivity in regards to the diagnosis of sarcopenia and also the objective muscle function parameters cross-sectionally. Demographic and clinical data were collected including age, sex, height (cm), weight (kg), mid-arm circumference (cm), arm-span (cm), waist circumference (cm), need of walking assistance, level of education, financial status, living alone (yes/no), number of illnesses, number of regular drugs, tobacco and alcohol use, weight loss after age 25 years>= 5 kg, falls in the previous year, the Katz Index of Independence in Activities of Daily Living(Katz ADL) and the Lawton Instrumental Activities of Daily Living Scale (IADL) measurements, quality of life (EQ-5D) nutritional status (Mini Nutritional Assessment) (12-15). The ADL and IADL scores were modified to document intermediate functional scores i.e. for each item, the subject was asked whether they did the activity without help (3 points), with some help (2 points), or they did not do the activity at all or they were completely dependent on someone to do the activity for them (1 point) (16). Four different current sarcopenia definitions [European Working Group on Sarcopenia in Older People's (EWGSOP); Foundation for the National Institutes of Health (FNIH), International Working Group on Sarcopenia (IWGS) and Society on Sarcopenia, Cachexia and Wasting Disorders (SCWD)] were included (17-20).

Measurement

Muscle mass was assessed by bioimpedance analysis (TANITA BC-532). Muscle mass was evaluated by adjustment by height^2 (m^2) as i.e. in the EWGSOP, IWGS, SCWD or by body mass index (BMI) as suggested in the FNIH definition. Objective functional parameters that were included in our study were presence of poor performance in hand grip strength (HGS), low gait speed, chair sit to stand test (CSST), functional reach test (FRT) and short physical performance battery (SPPB). Hand grip strength was assessed by Jamar hydraulic hand dynamometer. Gait speed was assessed by 4 meter usual gait speed (UGS). Chair sit to stand test, functional reach test and SPPB were performed as outlined elsewhere (21-24). In the chair sit-to-stand test, the subjects were asked to rise from a chair 5 times as fast as possible with their arms folded across their chests. The chair was of a standard height and did not have armrests. Two trials were conducted per session, and the shortest time was selected for analysis. FRT was performed by using a whiteboard mounted on the wall at shoulder height, subjects were asked to reach as far forward as possible in a plane parallel with the measuring device. They were instructed to reach as far forward as subject can without taking a step. If, during any trial, the base of support moved, data was discarded and the test repeated. The performance on three trials was then recorded, with results expressed as the maximum value over three trials (25). Frailty was screened by FRAIL scale (26).

Statistical analysis

Normality of variables were assessed. Numerical variables are given as mean ± standard deviation for normally distributed variables and as median for skew-distributed variables.

Categorical variables were represented as frequencies. For the first phase, translation and cross-cultural validation of the SARC-F, reliability was assessed by internal consistency, inter-rater and test–retest analyses. The inter-rater reliability and test-rest reliability was tested by intraclass correlation coefficient (ICC) provided that SARC-F total scores were normally distributed. ICC estimates and their 95% confident intervals were calculated based on a single measurement, absolute agreement, two-way mixed-effects model. Reliability assessed by ICC estimates were defined as follows: ICC estimate [0.90: excellent reliability, between 0.75 and 0.9: good reliability, 0.5–0.75: moderate reliability, <0.5: poor reliability]. Internal consistency was tested by Cronbach's alpha coefficient. The coefficient value> 0.70 indicates a high level of internal consistency (27). For the clinical validation phase of the SARC-F, population was divided between sarcopenic and non-sarcopenic as suggested by the SARC-F questionnaire. Diagnoses of sarcopenia according to the definitions used for the diagnosis were presented. A Chi2 test was used to measure difference of diagnosis between the SARC-F and the 4 operational sarcopenia definitions. Consequently, sensitivity (Se), specificity (Sp), positive predictive value (PPV) and negative predictive (NPV) value of the SARC-F according to the 4 operational sarcopenia definitions, muscle mass measures and the objective functional parameters were assessed. Sensitivity was calculated as the proportion of subjects with sarcopenia, low muscle mass or low functional performance based on the reference diagnosis when identified positive by the SARC-F test. Specificity was calculated as the proportion of individuals without sarcopenia, low muscle mass or low functional performance based on the reference diagnosis when identified negative by the SARC-F test. The PPV represented the probability of actually having sarcopenia, low muscle mass or low functional performance when SARC-F was positive and NPV the probability of actually not having sarcopenia, low muscle mass or low functional performance when the SARC-F was negative. $p<0.05$ was considered as statistically significant.

Results

First phase-Translation and Cultural Adaptation

Step 1-5 had been performed without any difficulty. Of note, the first item of the SARC-F, ''Strength'', questioning ''How much difficulty do you have in lifting and carrying 10 pounds?'' was translated/ adapted as 5 kg instead of the precise mathematical calculation (4.54 kg) in order to ease the practical understanding of the question as suggested by the EUGMS sarcopenia SIG (3). The pretest step included 5 older men and 5 older women (mean age: 71.5 ± 10.4 years) with no problems in comprehension of SARC-F items. Inter and intra rater reliability testing included 20 participants (10 male and 10 female) with mean age: 71.4± 8.1 years. Inter-rater reliability was performed resulting in ICC of 0.78 (95% CI : 0.60-0.89) indicating good inter-rater reliability. The intra rater reliability was performed resulting in ICC of 0.78 (95% CI: 0.61-0.90) indicating good inter-rater reliability as well. Turkish translation of SARC-F is given in supplementary Table 1.

Second phase- Clinical Validation

Population

207 subjects meeting the inclusion criteria were included between August 2016 and August 2017. 140 (67.6%) were women. The mean age were 75.4±5.9 years and 74.2±7.1; mean BMI were 28.7±4.7 kg/m2 and 31.5 ±6 kg/m2 in males and females, respectively. Screening by SARC-F indicated that 10.4% and 22.9% of males and females had positive screening suggestive for sarcopenia. The demographic, clinical and sarcopenia related characteristics of the population are outlined in Table 1.

Table 1
Characteristics of the clinical validation study participants

	Male (n=67)	**Female (n=140)**
Age (years)	75.4±5.9	74.2±7.1
Anthropometric data		
Height (cm)	165±6.6	151.4±5.5
Weight (kg)	78.6±14	72.3±15.1
BMI (kg/m2)	28.7±4.7	31.5±6.0
Calf circumference (cm)	37.2±3.6	37.2±4.3
Waist circumference (cm)	102.3±12.4	100.7±13.4
Mid-arm circumference (cm)	28.1±3.1	29.5±3.8
Education		
Illiterate	12%	35.7%
Primary school	35.8%	39.3%
Secondary school	23.8%	17.9%
College	28.4%	7.1%
Number of illnesses	4.4±1.8 (4)	4.3±2.2 (4)
Number of regular drugs	7.5±3.7 (7)	6.5±3.5 (6)
Smoking		
Yes	13.4%	10.1%
Alcohol		
Yes	9.7%	1%
Falls in past year	37.3%	46.4%
Katz ADL score	17.5±1.1	17.3±1.3
Lawton IADL score	21.1±4.4	21.1±4.1
Nutritional status (MNA)		
Malnutrition	4.5%	5.7%
Malnutrition risk	16.4%	27.1%
Normal nutrition	79.1%	67.1%
Quality of life (EQ-5D)	6.7±1.6	8.2±2.2
FRAIL point	0.97±1.2 (1)	1.6±1.3 (1.5)
FRAIL		
Frail	14.9%	27.1%
Prefrail	37.3%	46.4%
Robust	47.8%	26.4%

Table 1 (continued)
Characteristics of the clinical validation study participants

	Male (n=67)	Female (n=140)
SMM/height2	11.0±1.3	10.1±1.1
Hand grip strength (kg)	32.7±7.6	21.1±5.4
Gait speed (m/s)	0.98±0.25 (1.05)	0.86±0.24
Functional reach test	29.2±6.9	26.9±6.2
Chair sit to stand	11.6±2.9 (10.9)	12.6±4.2 (11.4)
SPPB	10.3±2.4	9.58±2.7
SARC-F total score	1.31±2.2 (1)	2.1±2.4 (1)
SARC-F Question 1/Strength		
None	82.1%	53.6%
Some	10.4%	20.7%
A lot	7.5%	25.7%
SARC-F Question 2/Assistance in walking		
None	87.9%	85.7%
Some	9.1%	13.6%
A lot	3%	0.7%
SARC-F Question 3/Rise from a chair		
None	84.8%	80.7%
Some	10.6%	17.1%
A lot	4.5%	2.1%
SARC-F Question 4/Climb stairs		
None	83.6%	65%
Some	7.5%	19.3%
A lot	9%	15.7%
SARC-F Question 5/Falls		
None	61.2%	55.7%
Some	31.3%	38.6%
A lot	7.5%	5.7%
SARC-F screening positive (>=4 points)	10.4%	22.9%
Prevalance of sarcopenia		
EWGSOP	10.4%	0.7%
FNIH	9%	9.3%
IWGS	4.5%	0.7%
SCWD	6%	0.7%

Data are given as mean±standard deviation (median) as appropriate; FRAIL, simple frailty questionnaire; SMM, skeletal muscle mass; SMMI, skeletal muscle mass index; SPPB, short physical performance battery; EWGSOP, European Working Group on Sarcopenia in Older People's; FNIH, Foundation for the National Institutes of Health; IWGS, International Working Group on Sarcopenia; SCWD, Society on Sarcopenia Cachexia and Wasting Disorders.

The prevalence of sarcopenia varied from 1.9% (IWGS) to 9.2% (FNIH). The performance of the Turkish version of the SARC-F questionnaire is outlined in Table 2. The sensitivity ranged from 25% (EWGSOP) to 50% (IWGS). The specificity were around 82% for all (Table 2). The sensitivity were around 20% for low muscle mass adjusted by height2 and BMI while specificity were around 81%. The sensitivity for functional measures (i.e HGS, UGS, Chair sit to stand test, functional reach test and SPPB) were between 33.7%-59.1% and specificity between 85.8-99.3%. The sensitivity and specificity for frailty screening was 52.1% and 91.2%, respectively.

The PPVs indicate the probability of having sarcopenia when SARC-F was positive and were always below 50% , with a minimum of 5.1% The NPV indicates a good probability of not suffering from sarcopenia in case of a negative screening by SARC-F and were always >90%.

Discussion

In this study, we performed the cross-cultural adaptation and clinical validation of Turkish version of the SARC-F questionnaire. SARC-F is a very practical tool with established performance to predict the adverse outcomes of sarcopenia and suggested to be one of the best tools to evaluate sarcopenia in practice (3). European Union Geriatric Medicine Society (EUGMS) special interest group on sarcopenia took the liberty to chair and coordinate a study to promote the validation with consequent use of SARC-F across Europe and world. This study in part stands as one of the fruitful products of this initiative. Apart from testing performance of SARC-F against the recommended 4 operational definition of sarcopenia, we also tested SARC-F's performance in regard to muscle mass measures and a wide variety of objective functional parameters related to the muscle function. To our knowledge, it is the first time that SARC-F has been tested against muscle mass measures and a wider variety of functional parameters that include hand grip strength, low gait speed, chair sit to stand test, functional reach test and short physical performance battery (SPPB) coupled with frailty screening.

This study demonstrates that the Turkish version of SARC-F is appropriately translated, cross-culturally adapted and valid. The methodology was performed exactly as defined by the EUGMS SIG initiative. The inter-rater reliability and the test–retest reliability showed good psychometric properties so that this version can be confidently and efficiently used by clinicians and researchers.

Regarding the clinical validation against the current sarcopenia definitions, results were concordant with the results yielded in the initial English validation of this questionnaire 27. The sensitivity was poor, in general, below 50%, and at most 50% (-with IWGS definition). The low sensitivity indicates the low capacity of a screening tool to detect subjects having sarcopenia. On the other hand SARC-F exhibited excellent specificity (>80%, for all definitions used to diagnose sarcopenia). The high specificity points out that this questionnaire is able to determine the absence of sarcopenia with great accuracy. This point, in fact, indicate an advantageous point for a screening test, because it implies that when an older adult is screened as negative by the SARC-F questionnaire, this is a trustful designation. This enables to avoid unnecessary testing which may cause the older adult to have unnecessary testings in worth of time, radiation exposure

Table 2
Sensitivity, specificity, positive and negative predictive values of Turkish version of the SARC-F questionnaire according to different definitions of sarcopenia, low muscle mass and parameters of muscle function

Parameter	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
EWGSOP	25 (7.1-59.1)	81 (75.4-86.2)	5.1 (1.8-12.1)	96.4 (93.6-99.2)
FNIH	32 (15.4-54)	82 (76.4-87.2)	15.4 (4.1-26.7)	92.3 (88.2-96.3)
IWGS	50 (15-85)	81.8 (75.9-86.5)	5.1 (-1.8-12.1)	98.8 (97.2-100.4)
SCWD	40 (11.8-76.9)	81.7 (75.8-86.4)	5.1 (-1.8-12.1)	98.2 (96.2-100.2)
LMM (Height)	20 (4.8-44.8)	81.2 (75.8-86.7)	5.1 (1.8-12)	95.2 (92-98.4)
LMM (bmi-FNIH)	18.7 (12.2-25.2)	80.9 (71.5-90.2)	66.7 (51.9-81.5)	32.7 (25.6-39.8)
HGS-T	33.7 (24.2-43.2)	93.7 (89-98.2)	82.1 (70-94.1)	61.8 (54.4-69.2)
HGS-FNIH	50 (31.5-68.5)	85.8 (80.6-91)	35.9 (20.8-51)	91.5 (87.3-95.8)
UGS	58.3 (45.7-70)	97.3 (93.2-98.9)	89.7 (80.2-99.3)	85.1 (79.7-90.5)
Chair sit to stand	39.2 (27-52.9)	97.8 (93.8-99.3)	87 (73.2-100.7)	81.4 (75.5-87.3)
FRT	9.1 (38.5-79.6)	88.1 (83.4-92.9)	38.2 (21.9-54.6)	94.5 (91.1-98)
SPPB	55.2 (43.3-67.1)	99.3 (97.9-100.6)	97.4 (92.2-102.5)	82 (76.2-87.9)
FRAIL	52.1 (38.3-65.5)	91.2 (85.8-947)	64.1 (49-79.2)	86.3 (81.1-91.5)

PPV, positive predictive value; NPV, negative predictive value; EWGSOP, European Working Group on Sarcopenia in Older People's; FNIH, Foundation for the National Institutes of Health; IWGS, International Working Group on Sarcopenia; SCWD, Society on Sarcopenia Cachexia and Wasting Disorders; LMM, low muscle mass, UGS, usual gait speed; *Low HGS-T: low hand grip strength according to Turkish cut-offs (<22 kg and <32 kg in females and males, respectively); *Low HGS-FNIH: low hand grip strength according to FNIH cut-offs (<16 kg and <26 kg in females and males, respectively); *Low UGS: defined as UGS <=0.8 m/s usual gait speed; *Chair sit to stand: low performance in test is defined as ≥10 s; *FRAIL: Simple frailty questionnaire is defined as frail (3–5), pre-frail (1–2), and robust (0); *FRT: Functional reach test: Poor FRT was defined as <15 cm (24); *SPPB: short physical performance battery: Poor SPPB is defined as <= 9 points (30).

and cost. In this context, the PPV was low and NPV was high which is also in accordance with not only the original validation of the SARC-F questionnaire (28) but the other translated/ adapted versions (5-10).

Regarding the clinical validation against the low muscle mass and functional measures, we found that the sensitivity was lower for the muscle mass measures but higher for the functional measures when compared with the results for the 4 sarcopenia definitions. Among the functional measures, the lowest sensitivity was with the chair sit-to-stand test which had higher sensitivity than the EWGSOP and FNIH definitions of sarcopenia. Also, the sensitivity for frailty screening was higher and similar to the functional measures. The specificity was higher for all functional measures and frailty screening and similar for muscle mass measures when compared with the 4 sarcopenia definitions. This finding is coherent with our suggestion that SARC-F will have higher sensitivity to detect poor muscle function, would be an efficient screening test for functional measures while it would have lower sensitivity to detect low muscle mass (LMM). It is apparent that SARC-F inquires status of functional measures with no inquiry on a measure of muscle mass. The co-presence of low muscle mass and muscle function is involved in all the current definitions of sarcopenia. Thus it is not surprising that SARC-F exhibited low sensitivity for sarcopenia diagnosis. Recently, it is stated that combination of SARC-F with the calf circumference (SARC-CalF) improves the sensitivity and diagnostic accuracy of SARC-F for screening which is in line with this view (29).

This study has some limitations and strengths. We assessed muscle mass by bioimpedance analysis which is less accurate than DXA. Neverthless, BIA is a suggested method of muscle mass assessment in both clinical and research practice. Additionally, we have documented Turkish cut-off points for muscle mass measurements performed by BIA and these were used in this study. The study participants were not randomly selected community dwelling older adults but among the community living older adults that apply to the geriatric outpatient clinic. That is, these subjects were not representative of the community dwelling Turkish adults but they were among the geriatric outpatients that we meet in our everyday practice.

In conclusion, the Turkish version of SARC-F is presented with the similar psychometric performance to the original SARC-F. It revealed low sensitivity but high specificity with all sarcopenia definitions. Sensitivity and specificity were higher for muscle function tests reflecting its inquiry and input on functional measures. Our findings suggest that SARC-F is an excellent test to exclude muscle function impairment and sarcopenia. It is relatively a good screening test for functional measures.

Conflicts of interest: The authors declare no conflict of interest.

Ethical standard: The authors declare that the study procedures comply with current ethical standards for research involving human participants in Turkey. The study protocol had been approved by Istanbul University, Istanbul Medical School Ethics Committee.

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