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SARC-F: an effective screening tool for detecting sarcopenia and predicting health-related quality of life in older women in Sri Lanka

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Abstract

Objective The "Strength, Assistance with walking, Rise from a chair, Climb stairs, and Falls" (SARC-F) is a simple, five-item tool used to identify individuals with suggestive signs of sarcopenia. This study assessed the validity of the Sinhala version of the SARC-F, evaluating its ability to detect sarcopenia in older women and its potential to predict health-related quality of life (HRQoL).

Methods The culturally adapted Sinhala version of the SARC-F, along with the Short Form-36 (SF-36) survey, was administered among 350 older women (aged ≥ 65) attending medical clinics at National Hospital Galle, Sri Lanka. Handgrip strength (HGS) was measured using a handheld dynamometer, and relative appendicular skeletal muscle mass index (RSMI) was estimated with a Sri Lankan-specific anthropometry-based equation. Gait speed (GS) was assessed using 4-m customary-paced walk test.

Results The mean (± SD) age of the participants was 72 (± 5) years, with 56.3% ($n = 197$) having sarcopenia based on a SARC-F score of ≥ 4. The Sinhala version of SARC-F demonstrated a good internal consistency (Cronbach's alpha = 0.72). A significant positive correlation between SARC-F and HGS indicated concurrent validity ($r = 0.23$, $p < 0.001$). Women with sarcopenia had significantly lower HRQoL scores, HGS and GS compared to those without, confirming discriminant validity ($p < 0.01$). The sensitivity, specificity, and accuracy of the Sinhala SARC-F were 54.8%, 67.3%, and 60.3%, respectively, with an Area Under the Curve (AUC) of 0.61 (95% CI: 0.55–0.67) in detecting probable sarcopenia. The HRQoL domains of SF-36 (excluding emotional well-being), HGS and GS were inversely correlated with SARC-F (Spearman's rho range: -0.19 to -0.56, $p < 0.001$). SARC-F significantly associated with the physical function and pain domains of SF-36 explained 42% of the variance in the model ($r = 0.65$, $R2 = 0.42$).

Conclusions The Sinhala version of SARC-F is a reliable and valid tool for screening sarcopenia in Sinhala-speaking older women in Sri Lanka. It can be integrated into clinical practice to identify those with suggestive signs of sarcopenia and to predict HRQoL enabling timely interventions. Future studies with larger, more diverse populations, including men, are needed to enhance the tool's generalizability and diagnostic accuracy.

Keywords Older women, SARC-F, Sarcopenia, Screening tool, Sri Lanka

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Background

Sarcopenia, a progressive and generalized skeletal muscle disorder characterized by the loss of muscle mass, strength, and physical performance is a condition commonly associated with aging and has been classified under the International Classification of Diseases (ICD-10) since 2016 [1]. Following the operational definition and diagnostic algorithm introduced by the European Working Group on Sarcopenia in Older People (EWGSOP) [2], the disease has gained renewed attention among researchers and clinicians.

Compared to young, sarcopenia is more prevalent among older people and it is associated with poor clinical outcomes such as falls, loss of independence, disability, worsening of comorbidities, mortality and increased healthcare costs [3]. Early detection of sarcopenia is crucial in order to reverse the disease process or mitigate its progression. Clinicians and researches encountered practical difficulties in detecting sarcopenia as per the EWGSOP 2010 diagnostic algorithm [2] since the low muscle mass was an essential component of the diagnostic criteria and clinicians had no easy access to technologies such as dual energy x-ray absorptiometry (DXA) and quantitative Magnetic Resonance Imaging (MRI) to measure muscle mass. The revised EWGSOP guidelines in 2019 [4], however, emphasized the relevance of muscle strength and function as key components of sarcopenia and these are relatively easy indices to measure compared to the muscle mass, especially in clinical settings. The probable sarcopenia introduced in 2019 based on muscle function alone allows clinician to initiate further investigations and management strategies [4]. This approach in clinical applications of sarcopenia has been endorsed by the Asian Working Group of Sarcopenia (AWGS) as well [5].

Early detection of sarcopenia requires a valid and simple screening tool to identify those at high risk of the condition and both the EWGSOP and AWGS recommend the use of the "Strength, Assistance with walking, Rise from a chair, Climb stairs, and Falls" tool (SARC-F) for this purpose [4, 5]. The tool consists of five items and it can be readily used in community as well as clinical settings [6]. It is a self-reported short questionnaire that reflects the individual's perceptions of adverse outcomes of sarcopenia such as limitations in strength, walking ability, rising from a chair, stair climbing and experiences with falls which are directly related to muscle function [7]. A SARC-F score of ≥ 4 indicates individuals with suggestive signs of sarcopenia (high risk for sarcopenia), who experience lower health-related quality of life (HRQoL) and higher mortality risk [8].

The SARC-F has been identified as a reliable screening tool for sarcopenia in various studies. In Western populations, it demonstrates moderate sensitivity (50–60%) and specificity (60–80%), depending on the cut-off point used [1, 9–13]. It correlates strongly with physical performance measures like handgrip strength (HGS) and gait speed (GS), which are key indicators of muscle function. Individuals with higher SARC-F scores typically exhibit lower HGS and slower GS, reflecting functional impairments associated with sarcopenia [1, 9, 10, 14]. While not a diagnostic tool, the SARC-F helps identify individuals requiring further evaluation using precise methods like DXA or MRI.

However, the SARC-F has limitations in diagnostic accuracy. Its relatively low sensitivity may miss individuals with early or mild sarcopenia. Additionally, it primarily assesses physical function rather than muscle mass, which is critical for diagnosing sarcopenia. Some studies suggest reduced accuracy in populations with comorbidities affecting physical function, such as obesity or neurological disorders [15, 16]. Despite these limitations, the SARC-F has been adapted into various languages and cultural contexts, expanding its global applicability [1, 9–13].

Performance of the tool may vary due to cultural differences in physical activity, healthcare access, and lifestyle factors. The simplicity and ease of use of the SARC-F make it a promising screening option, particularly in resource-constrained settings like Sri Lanka, where sarcopenia is an emerging public health concern. Hence, validating the Sinhala version of the SARC-F would enhance its applicability, contributing to global efforts to broaden sarcopenia screening tools and provide equitable healthcare for older adults in Sri Lanka.

This study also highlights the relationship between sarcopenia and HRQoL in a non-Western context. By linking the SARC-F with HRQoL indicators, it highlights the tool's utility in predicting the broader consequences of sarcopenia, essential for advancing geriatric care. The findings provide more support for sarcopenia screening in older women and highlight the necessity of holistic care approaches that target both physical and mental health.

Thus, the study assessed the validity of the Sinhala version of the SARC-F, examining its ability to detect sarcopenia in older women and its potential to predict HRQoL. It plays a vital role in contributing to global knowledge and improving healthcare outcomes for older populations.

Methods

This study comprised two phases: the cross-cultural adaptation of the SARC-F, followed by administering the adapted tool to assess the validity of the Sinhala version

of the SARC-F, its ability to detect sarcopenia in older women and its potential to predict HRQoL.

Phase 1—cross-cultural adaptation of SARC-F to Sinhala language

The standard guidelines outlined by Beaton et al. [17] were followed for the cross-cultural adaptation of the Sinhala version of SARC-F. First, the original English version was translated (forward translation) into Sinhala by two independent individuals, a health professional and a layperson, both fluent in Sinhala and English. One translator was informed about the purpose of the translation, while the other was not. The two translations were then consolidated into a single version to maximize clarity. The investigators synthesized a common translation, which was then back-translated into English (backward translation) by two independent individuals fluent in both languages. This step ensured comparability with the original version and confirmed there were no major inconsistencies or conceptual errors.

A group of experts independently reviewed all versions and finalized a pre-final Sinhala version. They ensured semantic, idiomatic, experiential, and conceptual equivalence with the original version. Once content validity was established, the pre-final version was further tested for clarity, understandability, and naturalness in a focus group discussion (FGD) with 30 older women from a different geographical area in the Galle district, ensuring face validity. The time taken to complete the questionnaire and any logistical issues during data collection and analysis were also assessed.

After addressing ambiguities and making necessary modifications, the final version was produced. Internal consistency was evaluated to ensure the reliability of the questionnaire before commencing the formal data collection.

Phase 2—evaluation of the validity of the Sinhala version of the SARC-F, its ability to detect sarcopenia in older women and its potential to predict HRQoL

Study design, setting and sample

A hospital-based cross-sectional survey was conducted with 350 older women selected using the systematic random sampling aged ≥ 65 years attending medical clinics at National Hospital Galle (THK), the largest tertiary care hospital in Southern Sri Lanka. The population composition and socio-economic characteristics of the residents in the hospital's catchment area closely resemble those of the general population across the country (http://www.statistics.gov.lk/).

The sample size was calculated based on an estimated prevalence of older women exhibiting suggestive signs of sarcopenia (as indicated by the SARC-F) at approximately 50%, using the appropriate formula, $n = Z^2 P (1\text{-}P)/d^2$ [18] [Z = 1.96, *P* = anticipated population proportion, d = absolute precision required for the estimate to fall within the given percentage point of the proportion (5%)].

The daily clinic register was used as the sampling frame. The clinic consisted of approximately 1150 registered women aged above 65 years. Every 3rd woman listed in the clinic register was invited to participate in the study. Only those who provided consent were included in the study. Patients with acute illnesses and those diagnosed with dementia (verified by the medical records or caregiver) were excluded from the study.

Ethical considerations

Ethics approval for this study was granted by the Ethics Review Committee, Faculty of Medicine, University of Ruhuna, Sri Lanka (Ref no: 2021.P.016: 17.02.2021). All participants provided informed consent, which was collected via an information sheet and consent form. All methods were conducted in accordance with relevant guidelines and regulations.

Data collection and tools

Data were collected using an investigator-administered questionnaire that included patient characteristics, the cross-culturally adapted SARC-F, and the previously validated Short Form-36 (SF-36) survey. Additionally, anthropometric measurements were taken to assess muscle quantity, muscle strength, and physical performance.

Questionnaire

The questionnaire included patient characteristics such as age, ethnicity, education, income, civil status, comorbidities, current medications, parity, years of lactation, age at menopause, and time since menopause.

The SARC-F is a five-item questionnaire designed to assess the individual with suggestive signs of sarcopenia, with items covering strength, assistance with walking, rising from a chair, climbing stairs, and falls. Answers in all components except falls are given on the following three-point scale: "no difficulty at all," "some difficulty," and "extreme difficulty or inability." Answers to the question on falls are given on the following three-point scale: "none at all," "1–3 falls," and "4 or more falls." For each item score ranges from of 0, 1, or 2 points and the total score from 0 (best) to 10 (worst) points. The total scores equal or above 4 indicates high risk for sarcopenia [7].

SF-36 survey includes 36-items to evaluate the HRQoL of individuals. SF-36 is an internationally validated questionnaire widely used in research to assess the HRQoL. It is a multi-purpose, short-form health survey under eight domains [19]. Further, a Sinhala version of SF-36 has

been validated previously [20]. In this questionnaire, each domain is given a score ranging from 0 to 100 using the original coding algorithm [19].

Muscle strength measurement

HGS (kg) was measured as the maximum isometric strength of the hand and forearm muscles [21] with the Lafayette hand held dynamometer (CAMRY Digital Hand Dynamometer, USA). The subject held the dynamometer in their dominant hand, with their arm at a right angle and their elbow by their side. The dynamometer handle was adjusted so that the base rested on the first metacarpal (heel of the palm) and the handle rested on the middle of the four fingers. The subject then squeezed the dynamometer with maximum isometric effort, which was sustained for approximately 5 s, with no other body movements allowed during the test. Three measurements were taken, and the average of these three values was recorded as the final handgrip strength value [21].

Muscle quantity assessment

The muscle quantity, specifically Appendicular Skeletal Muscle Mass (ASMM), was estimated using a validated anthropometry-based equation: [0.204(Weight) + 8.802(Height)-0.045(Age)-7.405] [22]. From this, the Relative Appendicular Skeletal Muscle Mass Index (RSMI) was calculated as ASMM per square meter (kg/m^2). This anthropometry-based equation was previously validated in the Sri Lankan context for women [22] and it has been proved that utilizing such equation are valid for muscle quantity assessment [4].

Physical performance assessment

GS (m/s) was measured using 4-m customary paced walking test [23]. The time taken to walk the central 4 m of an 8-m course at the participant's usual, self-selected pace was recorded with a stopwatch. GS was calculated by dividing the 4-m distance by the time taken to complete the walk in seconds. The initial and final 2 m of the course were excluded from the calculation to account for acceleration and deceleration effects [23]. The test was repeated twice, and the average of the two trials was used as the final gait speed value.

Statistical analysis

The data were analyzed using SPSS version 25.0 and were presented as counts (percentages) for categorical variables and as means (SD) continuous variables. A p-value of < 0.05 was considered statistically significant. The analysis of the questionnaires followed the methodologies employed by previous researchers [7, 24].

Defining sarcopenia

The EWGSOP [4] working definition of sarcopenia was used to classify the subcategories of sarcopenia. Patients with low muscle strength were categorized as having probable sarcopenia, while low muscle quantity (RSMI) combined with low muscle strength (HGS) was classified as confirmed sarcopenia. If all three measures; muscle strength (HGS), muscle quantity (RSMI), and physical performance (GS) were low, the condition was identified as severe sarcopenia [4].

In the current study, the prevalence of sarcopenia was determined based on locally established cut-off values for the main measures include, RSMI: 5.03 kg/m^2; HGS: 9.66 kg and GS: 0.96 m/s [25]. Risk of sarcopenia (those showing the suggestive signs of sarcopenia) was identified using the SARC-F questionnaire, with a score of ≥ 4 indicating a high risk [7].

Reliability and validity of SARC-F

Overall reliability (internal consistency) was assessed using Cronbach's alpha. The considered cut-off values for Cronbach's alpha for internal consistency were (0.93–0.94), strong (0.91–0.93), reliable (0.84–0.90), robust (0.81), fairly high (0.76–0.95), high (0.73–0.95), good (0.71–0.91), relatively high (0.70–0.77), slightly low (0.68), reasonable (0.67–0.87), adequate (0.64–0.85), moderate (0.61–0.65), satisfactory (0.58–0.97), acceptable (0.45–0.98), sufficient (0.45–0.96), not satisfactory (0.4–0.55) and low (0.11) [26].

Discriminant validity was evaluated by comparing RSMI, HGS, GS, and HRQoL between participants with a SARC-F score of ≥ 4 and those with a score below 4, using the Mann–Whitney U test. The comparison was extended to include sociodemographic factors and other basic characteristics, such as disease prevalence and gynecologic information. The Chi-Square test (or Fisher's exact test, where appropriate) and the Mann–Whitney U test were used to compare groups with a SARC-F score of ≥ 4 and those with a score below 4. This analysis aimed to establish known-group validity, further ensuring the discriminant validity of the tool.

Concurrent validity was determined by examining the relationships between the SARC-F score and RSMI, HGS, GS, and HRQoL scores using Spearman's Rho. Considered cut-off values for Spearman Rho for correlation include 0.00 to 0.19: Very weak or no, 0.20 to 0.39: Weak, 0.40 to 0.59: Moderate, 0.60 to 0.79: Strong, 0.80 to 1.00: Very strong [27].

Additionally, the agreement between the prevalence of sarcopenia based on locally defined cut-off values and the risk of sarcopenia as identified by the SARC-F was analyzed using the Chi-Square test (or Fisher's exact test

where appropriate). This analysis was extended to assess the agreement between each item of the SARC-F and the overall risk of sarcopenia based on the SARC-F score, using the same statistical tests. Cohen's Kappa (κ) coefficient and Standard Error (SE) were also calculated to identify the agreement.

Ability to detect sarcopenia using SARC-F

The suitability of the SARC-F score of ≥ 4 as the cutoff value for local setup to detect probable sarcopenia was evaluated by calculating the following metrics: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), and negative likelihood ratio (LR-). These calculations were based on locally established HGS for detecting probable sarcopenia (HGS: 9.66 kg) [25].

Ability of SARC-F in predicting HRQoL

The correlation between the SARC-F score and the domains of HRQoL of SF-36 were identified applying the Spearman Rank Order Correlation (Spearman Rho). The HRQoL domains of the SF-36 that showed correlations with the SARC-F were included in a multivariate linear regression model. This model was further adjusted for the effects of age and body mass index (BMI, kg/m^2). Multicollinearity was checked to ensure that the inclusion of multiple HRQoL domains did not lead to inflated standard errors or biased coefficient estimates. Model fit was evaluated using R^2 and adjusted R^2 values, and residual analysis was performed to check for homoscedasticity and normality.

Results

Basic characteristics of the participants

The mean (SD) age of the participants was 72.3 (4.8) years. The majority were Sinhalese (94.9%) and had never been employed (82.8%). Most participants had a monthly income of less than 57 USD (89.1%) and only primary level education (81.4%). Nearly half were either widowed, divorced, or separated (49.4%) (Table 1).

Prevalent disease conditions among the participants included diabetes mellitus (34.1%, $n=110$), dyslipidemia (78.6%, $n=275$), ischemic heart disease (1.1%, $n=4$), hypertension (86.3%, $n=302$), respiratory diseases (27.8%, $n=97$), bone diseases (e.g., osteoporosis, osteoarthritis) (38.5%, $n=135$), thyroid diseases (16.6%, $n=58$), chronic kidney disease (4.3%, $n=15$), and anemia (5.4%, $n=19$). Descriptive statistics for the SARC-F, sarcopenic measures, and HRQoL scores are detailed in Table 2.

Table 1 Basic characteristics of the participants ($n=350$)

Characteristic		Mean (+SD) or Frequency (%)
Age (years)		72.3(+4.8)
BMI (kg/m^2)		21.9(+4.4)
Socio-demographic status		
Ethnicity	Sinhala	332 (94.9)
	Non-Sinhala	18 (5.1)
Civil status	Married	147 (42.0)
	Single	30 (8.6)
	Widowed/Divorced/Separated	173 (49.4)
Monthly income	< 57 USD	312 (89.1)
	≥ 57 USD	38 (10.9)
Education level	No schooling	27 (7.7)
	Up to Ordinary Level	286 (81.7)
	Up to Advanced level and beyond	37 (10.6)
Employment status	Unemployed	290 (82.9)
	Retired (not employed currently)	34 (9.7)
	Self-employed and employed	26 (7.4)
Gynecologic information		
Age at menopause (years)		48.5 (+4.9)
Time since menopause (years)		232 (+7.4)
Number of children		3 (+1)
Breast feeding duration		64.83 (+43.26)

BMI Body Mass Index, *USD* United States Dollar

Table 2 Descriptive statistics of SARC-F, Sarcopenic measures and HRQoL scores ($n = 350$)

Characteristic		Mean (+ SD) or Frequency (%)
Individual items of SARC-F		
Power	No difficulty at all	105 (30.0%)
	Some difficulty	110 (31.4%)
	Extreme difficulty or inability	135 (38.6%)
Walking	No difficulty at all	147 (42.0%)
	Some difficulty	162 (46.3%)
	Extreme difficulty or inability	41 (11.7%)
Raising from chair	No difficulty at all	89 (25.4%)
	Some difficulty	181 (51.7%)
	Extreme difficulty or inability	80 (22.9%)
Climb steps	No difficulty at all	52 (14.9%)
	Some difficulty	195 (55.7%)
	Extreme difficulty or inability	103 (29.4%)
Falls	None at all	241 (68.9%)
	1–3 falls	84 (24.0%)
	4 or more falls	25 (7.1%)
Sarcopenia related information		
HGS (kg)		10.63(+4.65)
RSMI (kg/m^2)		5.63 (+0.94)
GS (m/s)		0.70(+0.20)
SARC-F score		4.26 (+2.39)
Prevalence of		
Low HGS (< 9.66 kg)		158 (45.1%)
Low GS (< 0.96 m/s)		276 (78.9%)
Low RSMI (< 5.03 kg/m^2)		89 (25.4%)
Prevalence of sarcopenia		
Sarcopenia (based on local cut-off values) ($n = 158$)	Probable sarcopenia	109 (68.9%)
	Confirmed sarcopenia	5 (3.2%)
	Severe sarcopenia	44 (27.9%)
Sarcopenia (based on SARC-F ≥ 4)		197 (56.3%)
HRQoL scores		
Physical functioning		57.15 (+22.12)
Role limitation due to physical problems		43.85 (+46.48)
Role limitations due to emotional problems		74.76 (+42.83)
Energy/Fatigue		51.41 (+14.51)
Emotional wellbeing		62.68 (+11.69)
Social functioning		73.73 (+27.73)
Pain		54.15 (+24.77)
General health		51.77 (+19.03)
Overall HRQoL		58.69 (+19.34)

HGS Hand GRIP STRENGTH, *GS* Gait Speed, *RSMI* Relative Appendicular Skeletal Muscle Mass, *HRQoL* Health Related Quality of Life

Prevalence of sarcopenia

Based on local cut-off values, 158 participants (45.1%) were identified as having some form of sarcopenia. Among these, the prevalence of probable sarcopenia was 68.9% ($n = 109$), confirmed sarcopenia was 3.2% ($n = 5$), and severe sarcopenia was 27.9% ($n = 44$) (Table 2). Additionally, 56.3% ($n = 197$) of the women showed suggestive signs of sarcopenia (high risk) based on SARC-F score of ≥ 4.

Reliability and validity of the SARC-F

The SARC-F demonstrated good overall reliability with a Cronbach's Alpha of 0.72, and corrected item-total correlations ranged from 0.31 to 0.60.

Discriminant validity was confirmed by significantly lower HGS, GS, and HRQoL scores (excluding emotional wellbeing) in with SARC-F score ≥ 4 compared to those with the score < 4 (Table 3). Furthermore, women who were older, unemployed, with lower monthly incomes, and widowed or divorced were mostly belongs to the SARC-F score ≥ 4. Women with bone-related diseases, higher parity, longer periods of breastfeeding, and a longer time since menopause also showed higher scores of SARC-F indicating the suggestive signs of sarcopenia. These observations support the known-groups validity of the SARC-F tool which further ensure the discriminant validity (Table 3).

Appropriate concurrent validity of the tool was evidenced by moderate to strong correlations observed between the SARC-F score and HGS, GS, and HRQoL scores (Table 4).

Those reporting extreme difficulty or inability on each item of the SARC-F tool also had a higher prevalence of sarcopenia (SARC-F ≥ 4). Older women with SARC-F score of ≥ 4 reported a higher prevalence of sarcopenia according to local cut-off values (Table 5).

Ability to detect sarcopenia using SARC-F

The sensitivity, specificity, and accuracy of identifying the probable sarcopenia using SARC-F are shown in Table 6, The Area Under the Curve (AUC) was of 0.61 (0.55–0.67) (Table 6).

Ability of SARC-F in predicting HRQoL

The linear regression model indicated that the physical function domain and pain domain were significantly associated with the SARC-F score, explaining 42% of the variance ($R = 0.65$, $R^2 = 0.42$, SEE = 1.81) (Table 7). Among the HRQoL domains, physical functions domain showed a greater association with SARC-F ($\beta = -0.325$, $R = 0.57$, $R^2 = 0.33$, SEE = 1.95).

Discussion

We found that the Sinhala version of the SARC-F is a reliable and valid tool for screening sarcopenia among Sinhala-speaking older women in Sri Lanka while predicting HRQoL effectively. Hence, this study addresses a significant gap in clinical medicine and research regarding sarcopenia in Sri Lanka.

Reliability, validity of SARC-F tool and its ability to detect sarcopenia

The cultural adaptation and validation of the SARC-F were conducted according to well-accepted guidelines, ensuring accuracy in the cross-cultural adaptation process between the original English version and the translated Sinhala version. The SARC-F's original English version has been successfully translated and validated in several languages, demonstrating robust psychometric properties across different cultural contexts [6].

In the current study, we observed a good internal consistency and moderate sensitivity and specificity for the SARC-F. Similarly, versions of the SARC-F in German [15], Greek [16], Italian [17], and Vietnamese [18] have demonstrated good internal consistency, with Cronbach's alpha ranging from 0.67 to 0.93. However, many studies have reported lower sensitivity but higher specificity for the SARC-F questionnaire, including those in the German [9], Greek [10], Italian [11], Japanese [1], Polish [12], and Hong Kong [13] versions. In contrast, a Polish study found higher sensitivity (92.9%) and specificity (98.1%) for the SARC-F [28]. Findings from the Vietnamese version [18] are fairly similar to those of the current study [29]. The variation in ethnicity, age, and pathology among participants may account for the wide range of estimates of internal consistency, sensitivity, and specificity observed for the SARC-F.

The results on ability to detect sarcopenia using SARC-F including sensitivity and specific highlight a moderate level of diagnostic accuracy, which is consistent with findings from other populations that emphasize the limitations of SARC-F as a standalone screening tool. While SARC-F's simplicity, ease of administration and having a good internal consistency, make it attractive for large-scale use, the relatively low sensitivity suggests it may miss a substantial proportion of individuals with probable sarcopenia. Conversely, the moderate specificity indicates a risk of false positives, potentially identifying individuals with other functional impairments unrelated to sarcopenia.

These findings reinforce the need for complementary diagnostic approaches to improve the identification of sarcopenia. Combining SARC-F with objective measures, such as HGS, physical performance tests like GS and Short Physical Performance Battery (SPPB) test, or imaging-based assessments of muscle mass such as DXA or MRI, that enhance the diagnostic accuracy would be a better approach in this case [30].

Among the studies cited, ours is unique in using locally developed cut-off values as the gold standard for identifying sarcopenia, whereas most other studies have relied on established cut-off values defined by either the AWGS or the EWGSOP. Additionally, we utilized RSMI values

Table 3 Comparison of individuals with SARC-F ≥ 4 and SARC-F < 4 ($n = 350$)

Characteristic		SARC-F ≥ 4 ($n = 197$) Mean (+ SD) or Frequency (%)	SARC-F < 4 ($n = 153$) Mean (+ SD) or Frequency (%)	*P* value
Age (years)		73.14 (+ 4.75)	71.42 (+ 4.81)	0.001*
Socio demographic status				
Ethnicity	Sinhala	187 (53.4)	145 (41.4)	0.94**
	Non-Sinhala	10 (2.9)	8 (2.3)	
Civil status	Married	87 (24.9)	60 (17.1)	0.02**
	Single	10 (2.9)	20 (5.7)	
	Widowed/Divorced/Separated	100 (28.6)	73 (20.9)	
Monthly income	< 57 USD	182 (52.0)	130 (37.1)	0.005**
	≥ 57 USD	15 (4.3)	23 (6.6)	
Education level	No schooling	2 (5.7)	7 (2.0)	0.14**
	Up to Ordinary Level	160 (45.8)	126 (36)	
	Up to Advanced level and beyond	17 (4.9)	20 (5.7)	
Employment status	Unemployed	173 (49.4)	117 (33.4)	0.009**
	Retired (not engaged currently)	16 (4.6)	18 (5.1)	
	Self-employed and employed	8 (2.3)	18 (5.1)	
Gynecologic information				
Age at menopause		48.35 (+ 4.85)	48.72 (+ 4.94)	0.48*
Time since menopause		24.35 (+ 7.20)	21.82 (+ 7.26)	0.001*
Number of children		3 (+ 1)	2 (+ 1)	0.02*
Breast feeding duration		69.82 (+ 42.33)	58.41 (+ 43.74)	0.01*
Prevalent disease conditions				
Diabetes mellitus		64 (18.3)	46 (13.1)	0.62**
Dyslipidemia		151 (43.1)	124 (35.4)	0.32**
Ischemic heart diseases		3 (0.9)	1 (0.3)	0.44**
Hypertension		176 (50.3)	126 (36.0)	0.05**
Respiratory diseases		55 (15.7)	39 (11.1)	0.81**
Bone diseases (osteoporosis, osteoarthritis, etc.)		97 (27.7)	38 (10.8)	< 0.001**
Thyroid diseases		29 (8.3)	29 (8.3)	0.29**
Chronic kidney diseases		11 (3.1)	4 (1.1)	0.17**
Anemia		9 (2.6)	10 (2.9)	0.42**
Sarcopenia related information				
HGS (kg)		9.62 (4.60)	11.92 (4.41)	< 0.001*
RSMI (kg/m^2)		5.57 (0.86)	5.67 (1.00)	0.33*
GS (m/s)		0.64 (0.20)	0.79 (0.17)	< 0.001*
SARC-F score		6.01 (1.56)	2.01 (0.97)	< 0.001*
HRQoL scores				
Physical functioning		48.52 (+ 21.07)	68.26 (+ 18.17)	< 0.001*
Role limitation due to physical problems		31.47 (+ 21.07)	68.26 (+ 18.17)	< 0.001*
Role limitations due to emotional problems		68.86 (+ 46.05)	82.35 (+ 37.08)	0.003*
Energy/Fatigue		46.95 (+ 13.75)	57.15 (+ 13.46)	< 0.001*
Emotional wellbeing		62.55 (+ 11.73)	62.84 (+ 11.68)	0.81*
Social functioning		65.00 (+ 29.14)	84.98 (+ 21.07)	< 0.001*
Pain		44.47 (+ 23.68)	66.61 (+ 20.20)	< 0.001*
General health		45.63 (+ 17.24)	59.67 (+ 18.34)	< 0.001*
Overall HRQoL		51.68 (+ 18.56)	67.71 (+ 16.40)	< 0.001*

p values derived from **Chi square test of independence or Fisher's exact test and * Mann–Whitney U test

HGS Hand Grip Strength, *GS* Gait Speed, *RSMI* Relative Appendicular Skeletal Muscle Mass, *HRQoL* Health Related Quality of Life

Table 4 Correlation between SARC-F score and HRQoL scores, HGS and GS ($n = 350$)

Variable	Spearman rho (*p* value)
HRQoL scores	
Physical functioning	-0.56 ($p < 0.001$)
Role limitation physical health	-0.38 ($p < 0.001$)
Role limitation emotional problems	-0.19 ($p < 0.001$)
Energy/Fatigue	-0.43 ($p < 0.001$)
Emotional wellbeing	-0.09 ($p = 0.06$)
Social functioning	-0.42 ($p < 0.001$)
Pain	-0.53 ($p < 0.001$)
General health	-0.42 ($p < 0.001$
Overall HRQoL	-0.51 ($p < 0.001$)
Sarcopenia related parameters	
GS (m/s)	-0.46 ($p < 0.001$)
RSMI (kg/m^2)	-0.02 ($p = 0.67$)
HGS (kg)	-0.32 ($p < 0.001$)

HRQoL Health Related Quality of Life, *GS* Gait Speed, *RSMI* Relative Appendicular Skeletal Muscle Mass Index, *HGS* Hand Grip Strength

P values derived from Spearman Rank Order Correlation

derived from country-specific anthropometry-based equations. While the Japanese validation study [1] also employed a country-specific equation, most other studies used advanced methods such as DXA or Bioelectrical Impedance Analysis (BIA) to assess muscle mass.

We also observed that individuals with suggestive signs of sarcopenia were generally older and had poorer socioeconomic status. Those with a longer duration of menopause, having a greater number of children with longer breastfeeding duration, and having bone disease and suffering from many diseases were at high risk of sarcopenia. Similarly, a study done in Greece also identified that SARC-F had moderate correlations with age, and comorbidities [10]. In the current study, this observation of known group validity further ensures the discriminant validity, showing that those with poor socioeconomic status acquire sarcopenia compared to those with high status. Socioeconomic factors play a significant role in influencing the risk of sarcopenia. It is primarily associated with aging, but socioeconomic factors can exacerbate or mitigate this condition. These factors include income, education, occupation, access to healthcare, and living conditions, which collectively affect an individual's

Table 5 Agreement of prevalence of sarcopenia and sub-items of the SARC-F cut-off values with SARC-F ($n = 350$)

Variable	Criteria	SARC F < 4 ($n = 153$) Frequency (%)	SARC F ≥ 4 ($n = 197$) Frequency (%)	Chi value	*P* value	Kappa value	SE
Individual items of SARC F							
Power	No difficulty at all	91 (26.0%)	14 (4.0%)	148.44	< 0.001	0.17	0.03*
	Some difficulty	51 (14.6%)	59 (16.9%)				
	Extreme difficulty or inability	11 (3.1%)	124 (35.4%)				
Walking	No difficulty at all	111 (31.7%)	36 (10.3%)	109.35	< 0.001	0.39	0.04**
	Some difficulty	40 (11.4%)	122 (34.9%)				
	Extreme difficulty or inability	2 (0.6%)	4 (1.1%)				
Raising from chair	No difficulty at all	71 (20.3%)	18 (5.1%)	102.28	< 0.001	0.14	0.03**
	Some difficulty	80 (22.9%)	101 (28.9%)				
	Extreme difficulty or inability	2 (0.6%)	78 (22.3%)				
Climb steps	No difficulty at all	44 (12.6%)	8 (2.3%)	109.90	< 0.001	0.07	0.03**
	Some difficulty	105 (30.0%)	90 (25.7%)				
	Extreme difficulty or inability	4 (1.1%)	2 (8.3%)				
Falls	None at all	132 (37.7%)	109 (31.1%)	41.52	< 0.001	0.22	0.03**
	1–3 falls	20 (5.7%)	64 (18.3%)				
	4 or more falls	1 (0.3%)	24 (6.9%)				
Prevalence of sarcopenia							
Sarcopenia based on local cut-off values	None	103 (29.4%)	89 (25.4%)	22.60	< 0.001	0.15	0.04**
	Probable sarcopenia	35 (10.0%)	74 (21.1%)				
	Confirmed sarcopenia	4 (1.1%)	1 (0.3%)				
	Severe sarcopenia	11 (3.1%)	33 (9.4%)				

P values derived from the *Chi Square Test or **Fisher's exact test

SE Standard Error

Table 6 Ability to detect sarcopenia using SARC-F ($n=350$)

Criteria	Value (95% CI)
Sensitivity	54.82% (47.59% to 61.91%)
Specificity	67.32% (59.28% to 74.68%)
PPV	68.35% (62.47% to 73.70%)
NPP	53.65% (48.92% to 58.31%)
LR (+)	1.68 (1.29 to 2.18)
LR (-)	0.67 (0.56 to 0.81)

PPV Positive predictive value, *NPV* Negative predictive value, *LR (+)*Positive likelihood ratio, *LR (-)*Negative likelihood ratio, *CI* Confidence Interval

ability to maintain optimal health throughout their life. Understanding how socioeconomic factors influence the risk of sarcopenia is not only essential to ensure the validity of the tool to the local context, but also it leads for designing targeted public health interventions such as policies aimed at reducing socioeconomic disparities, nutrition programs targeting lower-income populations, physical activity initiatives in underserved communities especially for older adults.

In-line with our observations, the study conducted in Greece identified that SARC-F has strong correlations with HGS [10] and the study conducted by Drey et al., also recorded correlations with HGS, GS, peak toque for knee extension and SPPB test [9]. In the study conducted in Japan, reported a correlation between the presence of sarcopenia according to the SARC-F and fear of falling [1]. As stated by Noda et al. (2023), SARC-F is closely linked to motor functions and the reduced capability of performing tasks associated with muscle strength and function [14]. Contrary to emerging literature suggesting that SARC-F may correlate with muscle composition [31] and muscle mass index [10], our study did not find a significant correlation between SARC-F scores and muscle mass. The difference in the association of sarcopenia measured by the SARC-F with muscle mass may depend on the population characteristics and the technique of muscle mass measurement.

This emphasize that the tool relies on self-reported functional limitations and does not account for variations in muscle mass or composition, which are critical components in defining sarcopenia. Further, functional limits may result from causes other than sarcopenia, such as joint abnormalities, chronic diseases, or neurological impairments, from which the SARC-F makes no distinction. Moreover, functional decline captured by SARC-F may be more closely related to muscle quality (e.g., strength, endurance) than muscle quantity [32]. Thus, SARC-F scores might reflect functional impairments independent of measured muscle mass. This discrepancy emphasizes the limitations of SARC-F in objectively reflecting muscle quantity.

The ability of SARC-F in predicting HRQoL

We found moderate to strong inverse correlations between the total scores of HRQoL and SARC-F similar to the previous studies which observed negative influence on the HRQoL of individuals [12, 14, 33]. Further, our observations support the assumption that SARC-F is not only a simple screening tool of sarcopenia but also a predictor of patients' HRQoL. However, it was observed that, emotional wellbeing does not show any correlation with SARC-F score.

The SARC-F questionnaire is designed to assess functional limitations associated with sarcopenia, including muscle weakness, difficulties in mobility, and increased fall risk. These impairments have a well-documented impact on HRQoL by limiting independence, reducing social participation, and increasing psychological stress, such as anxiety and depression. The results of our study align with this understanding, demonstrating that individuals with higher SARC-F scores tend to report poorer

Table 7 Linear Regression Model of SARC-F with HRQoL domains of SF-36 ($n=350$)

Variable		Unstandardized Coefficients		Standardized Coefficients	*p* value	95.0% Confidence Interval for B	
		B	SE	β		Lower Bound	Upper Bound
Constant		10.71	0.68		< 0.001	9.36	12.06
SF-36 domains	***Physical Functions***	***-0.03***	***0.007***	***-0.32***	***< 0.001***	***-0.04***	***-0.02***
	Role limitation due to physical health	-0.004	0.003	-0.08	0.13	-0.01	0.001
	Role limitation due to emotional problems	-0.003	0.003	-0.04	0.32	-0.008	0.003
	Energy/Fatigue	0.000	0.002	-0.005	0.93	-0.005	0.005
	Social Functioning	-0.004	0.005	-0.04	0.45	-0.01	0.006
	Pain	***-0.02***	***0.006***	***-0.23***	***< 0.001***	***-0.03***	***-0.01***
	General Health	-0.006	0.007	-0.05	0.35	-0.02	0.007

P values derived from multivariate linear regression model adjusted for age and body mass index

SE Standard Error, *B* Unstandardized Coefficient, *β* Standardized Coefficient

HRQoL. However, it is crucial to recognize that SARC-F does not encompass broader domains of HRQoL, such as emotional well-being, which are influenced by various factors beyond muscle function. This highlights the need for an integrated approach to patient assessment that addresses both elements in SARC-F and broader psychosocial consequences.

Clinical implications of findings

This study is the first to validate the Sinhala version of the SARC-F questionnaire for screening of sarcopenia among Sinhala-speaking older women in Sri Lanka, addressing a critical gap in the availability of culturally and linguistically adapted tools for this population. Unlike previous studies that focused on general populations or other ethnic groups, this study provides context-specific evidence of the tool's reliability and validity in a developing nation scenario, where sarcopenia is still underdiagnosed and undertreated. This is particularly valuable in resource-limited environments where advanced diagnostic tools like DXA or CT scans are not freely available or impractical.

With the validation of a Sinhala version of SARC-F, we hope that healthcare professionals in Sri Lanka would actively screen older adults and those at high risk for the coexistence of sarcopenia and take necessary steps to reverse or mitigate its progression. At present sarcopenia is not routinely assessed partly due to the lack of a valid tool and poor awareness. We hope that the awareness of sarcopenia among healthcare professionals would improve when a reliable screening tool is made available.

The study's comprehensive evaluation of SARC-F's diagnostic accuracy (sensitivity, specificity, and AUC) for identifying probable sarcopenia, and predicting ability of HRQoL emphasize the importance of early screening for sarcopenia using tools like SARC-F in clinical and community settings. Identifying individuals with poor muscle function enables timely interventions, such as exercise programs, nutritional support, and fall prevention strategies, which can mitigate the negative impact of sarcopenia on HRQoL [34]. Furthermore, incorporating HRQoL assessments into routine care for older adults may help address the broader consequences of sarcopenia and promote holistic well-being. Healthcare providers can use the Sinhala SARC-F to identify older adults with functional impairments and prioritize them for further evaluation and interventions, such as physical therapy, nutrition counseling, or exercise programs aimed at improving muscle strength and function.

Strengths, limitations and recommendations

We were unable to find previous studies that validated sarcopenia screening tools in Sri Lanka, hence this would be the first approach of validating such a tool in the country. The study sample we used widely represent older adults in the Southern Province of Sri Lanka since study site provides free access and free health care for all individuals in the area. Further, the population composition and socio-economic characteristics of inhabitants in the catchment area of the hospital are very close to those seen in the entire country.

However, several factors that limits the generalizability and precision of the findings should be acknowledged. We were unable to screen inter-rater or intra-rater agreement (between doctors vs nurses etc.), test–retest reliability, used only the women who are a diseased population where sarcopenia would be much higher compared to a community population and estimated the body composition by anthropometry-based equations. These factors limit the confidence in the tool's reproducibility and performance in routine clinical practice even though it showed a good internal consistency. The exclusion of males from the study also limits its applicability to males.

Emphasizing the importance of future studies that include larger populations and men is crucial to enhance the generalizability and robustness of findings related to sarcopenia. While the current study focused on older women, who are at a heightened risk for sarcopenia due to age-related changes in muscle mass, strength, and function, it is equally important to expand research to include diverse populations, including men.

While the study provides valuable insights into the validity of the Sinhala version of SARC-F for detecting sarcopenia, further research is needed to explore its effectiveness in detecting sarcopenia across different ethnic and age groups, and to address the limitations in reliability and generalizability. Diagnostic accuracy of the SARC-F could be further refined by incorporating additional biomarkers, imaging techniques, and functional assessments. These improvements would allow for a more comprehensive evaluation of muscle health, providing better identification of individuals at risk of sarcopenia and facilitating more targeted interventions. However, the implementation of these enhancements should be balanced with considerations of accessibility, cost, and practicality in clinical settings to ensure that they do not limit the widespread use of the tool.

Conclusions

The Sinhala version of the SARC-F is a reliable and valid tool for screening sarcopenia and predict the HRQoL among Sinhala-speaking older women in Sri Lanka. However, its moderate sensitivity, specificity, and diagnostic accuracy, combined with a lack of correlation with muscle mass, highlight its limitations as a standalone measure. As a result, the SARC-F can be

included in the clinical assessment of older women that should be done routinely to identify who are at high risk of sarcopenia, alongside supplementary diagnostic tests and HRQoL assessment. It will provide a better alternative for screening sarcopenia, especially in settings where resources are limited. Future research should focus on evaluating the tool's utilization and effectiveness in clinical trials to further validate its benefits and adaptability in diverse healthcare environments.

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Authors' contributions
All authors involved in design of the study. NR contributed to data collection, data analysis, and manuscript drafting and revision. TA, GL, SS, WZ, DP involved in the revision of manuscript. SL contributed to data analysis and critically reviewing the manuscript for its accuracy and completeness. All authors read and approved the final manuscript.

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Data availability
The data used to support the findings of this study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate
Ethics approval for this study was granted by the Ethics Review Committee, Faculty of Medicine, University of Ruhuna, Sri Lanka (Ref no: 2021.P.016: 17.02.2021). All participants provided informed consent to participate, collected via an information sheet and consent form. The study was conducted according to the principles of the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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