Use of the SARC-F Score as an Aid in Fragility Fractures Prevention*

O uso do escore SARC-F como auxiliar na prevenção de fraturas por fragilidade

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Abstract

Objective The present study aimed to relate the strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) score with the presence or absence of fragility fracture in the population over 60 years of age.

Methods The risk of sarcopenia was determined through the application of the SARC-F questionnaire, and the patients were divided into 2 groups, according to the occurrence or not of fragility fracture (n = 100).

Results Thirty-two cases of distal radius fractures and eighteen cases of proximal femur fractures were identified. A higher score on the SARC-F is determinant between having or not a fragility fracture, estimating that for each point in the score there is a 70% increase in the chance of a patient having a fracture, regardless of age, gender, and body mass index (BMI).

Conclusion There was a direct correlation between a higher score on the SARC-F and an increase in the chance of fragility fracture.

Keywords

- risk factors
- osteoporotic fractures
- osteogenesis imperfecta
- osteoporosis
- sarcopenia

Resumo

Objetivo O presente estudo teve como objetivo relacionar o escore *strength, assistance with walking, rising from a chair, climbing stairs, and falls* (SARC-F) com a presença ou não de fratura por fragilidade na população acima de 60 anos.

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Palavras-chave
- fatores de risco
- fraturas por osteoporose
- osteogênese imperfeita
- osteoporose
- sarcopenia

Métodos O risco de sarcopenia foi determinado por meio da aplicação do questionário SARC-F, sendo os pacientes divididos em 2 grupos, de acordo com a ocorrência ou não de fratura por fragilidade (n = 100).
Resultados Foram levantados 32 casos de fratura de rádio distal e 18 casos de fratura de fêmur proximal. Uma maior pontuação no SARC-F determina bem entre ter ou não ter fratura por fragilidade, estimando que a cada ponto a mais no escore há um acréscimo de 70% na chance de o paciente ter fratura, independentemente da idade, sexo e índice de massa corporal (IMC).
Conclusão Houve correlação direta entre uma maior pontuação no SARC-F e aumento na chance de fratura por fragilidade.

Introduction

Fragility fractures are characterized by injuries resulting from low-energy trauma, usually a fall from the person's height, which possibly would not result in fracture in the case of a healthy bone structure.[1] In the Western world, approximately 1 in 3 women and 1 in 5 men over 50 years of age will suffer a fracture in their remaining lifetime.[2] These fractures occur more commonly in the hip, spine, and wrist, affecting mainly the elderly population, due to the higher incidence of osteoporosis.[3] Such fractures can lead to serious complications, decreasing the patient's quality of life, as well as being life-threatening in some cases. In addition, the cost to the health system of treating these fractures is high, since the chance of complications is considerable, and, in some cases, hospitalization and surgical treatment are necessary.[4,5]

In addition to osteoporosis, more recently, sarcopenia has been correlated with an increased likelihood of an individual suffering from fragility fracture.[6] Sarcopenia is defined by a decrease in muscle mass, leading to decreased performance capacity of daily activities and increased probability of unfavorable outcomes such as falls, fractures, and death.[7] The European Working Group on Sarcopenia in Older People (EWGSOP2) describes the strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) score as a screening for sarcopenia, being a low-cost tool, moderate sensitivity, and high specificity to predict low muscle mass in the studied population.[6,8–10] This is a useful tool for use in clinical practice to prevent the occurrence of fragility fracture.

The aim of this study was to relate the SARC-F score of patients with the presence or not of fragility fracture.

Materials and Methods

This was an observational, analytical study, approved by the ethics committee, under the opinion of number 4,463,378 - CAAE- 39467220.5.0000.5362.

Patients over 60 years of age, treated at the outpatient clinic of our hospital, from January to June 2021, who presented fragility fracture due to a fall from their own height were included in the present study; or who had never suffered any fragility fracture; and who agreed to participate in the study and signed the consent form.

Patients whose fractures were due to high-energy trauma were excluded from the study, as well as patients with alteration of cognition or memory that made them unable to answer the questionnaire, patients with deformities or motor limitations in the lower limbs prior to fracture, and fragility fractures that occurred more than 6 months ago.

Patients were allocated to two groups of 50 patients each:
a) Control group: patients who have never suffered fragility fractures;
b) Fracture group: patients who suffered fragility fractures.

Intervention

In addition to the demographic variables, information was collected regarding the patients' body mass index, fracture date, whether there were previous treatments for osteoporosis or sarcopenia, and the presence of absence of smoking.

The SARC-F score was the main study data collection tool used to identify patients at high risk of sarcopenia. The SARC-F assesses muscle strength, the need for walking assistance, the ability to get up from a chair, climb stairs, and the frequency of falls. Each item can be scored from 0 to 2, 0 being no difficulty, 1 some difficulty, and 2 very difficult or unable to perform. In the item *falls*, 0 corresponds to no falls, 1 corresponds from 1 to 3 falls, and 2 corresponds to 4 or more falls. The final score can range from 0 to 10, and the ≥ 4 score is considered predictive of sarcopenia (►**Table 1**).

The patients in the control group answered the SARC-F questionnaire when they underwent outpatient consultation due to other orthopedic pathologies (gonarthrosis, coxarthrosis, chronic shoulder injuries, phalanx fracture, etc.). The patients of the *fracture group* answered the SARC-F questionnaire at the time of the first outpatient return consultation, being instructed to give the answers according to their functional status immediately before suffering the fracture. All questionnaires were personally applied by the researchers.

Statistical analysis

The results obtained in the study were described by mean, standard deviation, minimum and maximum (quantitative

Table 1 SARC-F score

COMPONENTS	QUESTIONS	RESULTS
Strength	What is your difficulty in lifting or carrying 4 kg?	None = 0 Some = 1 A lot or incapable = 2
Walking assistance	What is your difficulty in walking through a room?	None = 0 Some = 1 A lot, with help or incapable = 2
Chair lifting	How hard is it to get out of bed or chair?	None = 0 Some = 1 Too much or unable without help = 2
Climb stairs	What's your difficulty in climbing 10 steps?	None = 0 Some = 1 A lot or incapable = 2
Falls	How many times have you fallen in the last year?	None = 0 1 to 3 falls = 1 4 or more falls = 2

Abbreviations: SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls.

variables) or by frequencies and percentages (categorical variables). For age, the 2 cutoff points, 65 and 73 years, were considered.

For SARC-F, classifications 0 or >0 and classifications 0, 1 or >1 were considered.

For the components of the SARC-F classifications, 1 and 2 were grouped, that is, the classifications *none* or *any/very or incapable*). The estimated association measure was the odds ratio (OR) for which a 95% confidence interval was presented. Values of $p<0.05$ indicated statistical significance. The data were analyzed with the Stata/SE v.14.1. software (StataCorp LLC, College Station, TX, USA).

Results

Of the 100 patients evaluated, the mean age was 70.1 years, and 58 of these patients were female (58%). Of the 50 patients who suffered fragility fractures, distal radius fracture was the most prevalent (64%), with the other being proximal femur fractures (36%) (►**Table 2**).

Table 2 Descriptive analysis of demographic and local characteristics of fractures

Features		N (%)
Gender	Male	42
	Female	58
Age	≤ 65	33
	>65	67
Fragility fracture	Yes	50
	No	50
Fracture site	Distal radius	32
	Proximal femur	18

Presence of Fragility Fracture versus SARC-F Score

A statistically significant difference was observed between the presence of fragility fracture and the SARC-F score ($p<0.001$), that is, patients who suffered fragility fractures had a higher SARC-F score (►**Table 3**).

A receiver operating characteristic (ROC) curve was adjusted for the SARC-F score considering the presence or absence of fracture. The area below the curve corresponded to 0.83 presenting statistical significance ($p<0.001$), indicating that the SARC-F score discriminates the presence or not of fracture (►**Fig. 1**).

The cut-off point indicated by the ROC curve adjustment was equal to 0. SARC-F equal to 0 is associated with absence of fracture, and SARC-F >0 was associated with the presence of fracture. The sensitivity of this cutoff point is equal to 90% and specificity is equal to 64%.

Presence of Fragility Fracture versus Patient Age

There was a statistically significant difference between the presence of fragility fracture and the age of the patients ($p<0.001$), that is, patients who suffered fragility fractures had the highest mean age (►**Table 4**).

A ROC curve was adjusted for the age of the patients considering the presence or not of fracture. The area below the curve corresponded to 0.79 presenting statistical significance ($p<0.001$), indicating that the age of the patients discriminates the presence or not of fracture (►**Fig. 2**).

Table 3 Presence of fragility fracture versus SARC-F score

Presence of fracture	N	SARC-F average score	*P** value
No	50	0.66	<0.001
Yes	50	2.86	

Abbreviations: *Student t-test for independent samples, considering $p<0.05$.

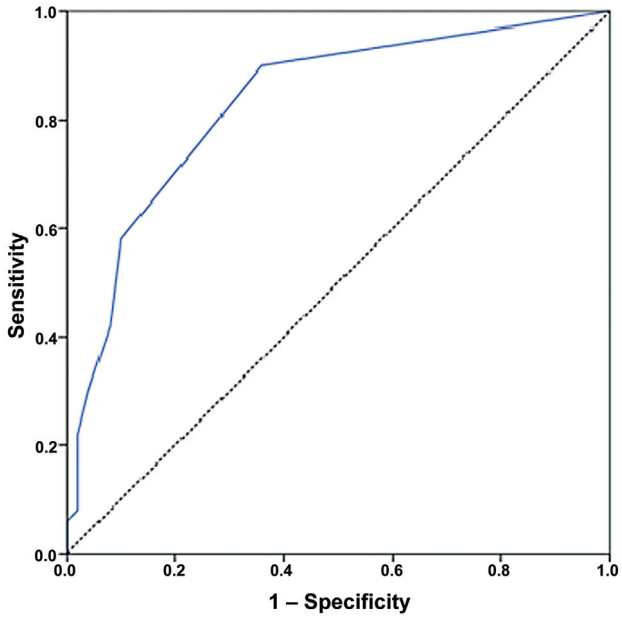

Fig. 1 Receiver operating characteristics curve for the SARC-F score considering the presence or absence of fracture.

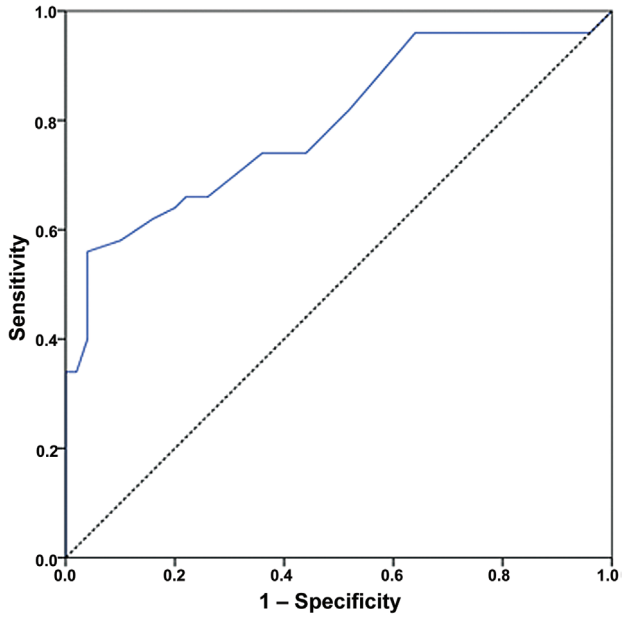

Fig. 2 Receiver operating characteristics curve for the age of patients considering the presence or absence of fracture.

Table 4 Presence of fragility fracture versus age of patients

Presence of fracture	N	Age (years)	p^*
		Mean (standard deviation)	
No	50	66.4 (±4.3)	< 0.001
Yes	50	73.8 (±7.5)	

Abbreviation: SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls.
*Student *t test* for independent samples, considering $p < 0.05$.

The cutoff point indicated by the ROC curve adjustment was 73 years of age. Age ≤ 73 years is associated with absence of fracture and age > 73 years is associated with the presence of fracture. The sensitivity of this cutoff point is equal to 56% and the specificity is 96%. If the cutoff point is equal to 65 years, the sensitivity is equal to 82% and the specificity is equal to 48%.

Association of Demographic Variables and Clinical Variables with the SARC-F Score

According to ►**Table 5**, of the variables analyzed, age, gender and treatment for osteoporosis presented statistical significance. That is, the older the patient, the higher the SARC-F

Table 5 Association of demographic variables and clinical variables with the SARC-F score

Variables	Category	N	SARC-F score	p^*
			Average	
Age (years)	≤ 65	33	1.03	**0.020**
	> 65	6 7	2.12	
Gender	Female	58	2.29	**0.002**
	Male	42	1.02	
BMI (kg/m^2)	< 25	28	2.36	0.126
	≥ 25	72	1.53	
Treatment for osteoporosis	No	71	1.20	**0.001**
	Yes	29	3.14	
Smoking	No	51	1.94	0.105
	Yes / Ex-smoker	49	1.57	

Abbreviation: SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls.
*Mann-Whitney nonparametric test, considering $p < 0.05$.

score ($p = 0.020$); women had a higher SARC-F score ($p = 0.02$); and patients undergoing treatment for osteoporosis had a higher SARC-F score ($p = 0.001$).

Evaluation of Fracture-Related Factors

For categorical variables, the percentages were calculated in relation to the totals in the rows (column n), that is, they add up to 100% in each row (►**Table 6**).

Age was an important factor in the occurrence of fractures, especially in the age group above 73 years, since these patients were about 30 times more likely to suffer fractures than younger patients. Female patients were 8 times more likely to suffer fractures (OR = 8.84). Considering body mass index (BMI) as an isolated variable, individuals with BMI below 25 kg/m^2 had a nearly three-fold higher chance of suffering fragility fracture. Smokers or former smokers had a lower rate of fractures in relation to the population that never smoked, as well as those who never underwent treatment for osteoporosis.

As for the variables of the SARC-F, patients who scored 0, that is, no difficulty to carry a weight of 4 kg, get up from the chair, climb 10 steps, and no fall in the last year, had a significant reduction in the risk of fragility fractures. Individuals who scored > 0 in the SARC-F were 16 times more likely to suffer fragility fractures than those with SARC-F equal to 0.

Multivariate Analysis

To evaluate the effect of SARC-F on the probability of having a fragility fracture, a multivariate model was

Table 6 Univariate analysis

Variable	Category	N	Presence of fracture		*P** value	OR (95%CI)
			No	Yes		
Age (years)	< 73 (ref)	70	48 (68.6%)	22 (31.4%)	< **0.001**	30.6 (6.68–140)
(ROC curve)	≥ 73	30	2 (6.7%)	28 (93.3%)		
Age (years)	< 65 (ref)	33	24 (72.7%)	9 (27.3%)	**0.002**	4.21 (1.69–10.4)
	≥ 65	67	26 (38.8%)	41 (61.2%)		
Gender	Male (ref)	42	33 (78.6%)	9 (21.4%)	<**0.001**	8.84 (3.49–22.4)
	Female	58	17 (29.3%)	41 (70.7%)		
BMI (kg/m^2)	≥ 25 (ref)	72	41 (56.9%)	31 (43.1%)	**0.029**	2.79 (1.11–7.01)
	<25	28	9 (32.1%)	19 (67.9%)		
Treatments for osteoporosis	No (ref)	71	43 (60.6%)	28 (39.4%)	**0.002**	4.83 (1.82–12.8)
	Yes	29	7 (24.1%)	22 (75.9%)		
Smoking	No	51	20 (39.2%)	31 (60.8%)	**0.029**	2.45 (1.09–5.47)
	Yes/Ex (ref)	49	30 (61.2%)	19 (38.8%)		
Strength	0 (ref)	84	47 (56%)	37 (44.1%)	**0.012**	5.51 (1.46–20.8)
	1 or 2	16	3 (18.8%)	13 (81.3%)		
Walking assistance	0 (ref)	85	46 (54.1%)	39 (45.9%)	0.059	3.24 (0.96–11.0)
	1 or 2	15	4 (26.7%)	11 (73.3%)		
Getting up from a chair	0 (ref)	78	46 (59%)	32 (41%)	**0.002**	6.47 (2.00–20.9)
	1 or 2	22	4 (18.2%)	18 (81.8%)		
Climbing stairs	0 (ref)	74	48 (64.9%)	26 (35.1%)	< **0.001**	22.1 (4.85–101)
	1 or 2	26	2 (7.7%)	24 (92.3%)		
Falls	0 (ref)	42	35 (83.3%)	7 (16.7%)	< **0.001**	14.3 (5.26–39.0)
	1 or 2	58	15 (25.9%)	43 (74.1%)		
SARC-F	0 (ref)	37	32 (86.5%)	5 (13.5%)	< **0.001**	16 (5.38–47.6)
	> 0	63	18 (28.6%)	45 (71.4%)		
SARC-F	0 (ref)	37	32 (86.5%)	5 (13.5%)		
	1	29	13 (44.8%)	16 (55.2%)	**0.001**	7.88 (2.39–26.0)
	> 1	34	5 (14.7%)	29 (85.3%)	**0.011**	37.1 (9.74–141)

Abbreviations: 95%CI, 95% confidence interval; Ex, former smoker; OR, odds ratio; Ref, reference; ROC, receiver operating characteristics; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls.
Legend: *Logistic regression model and Wald test considering $p < 0.05$.

Table 7 Multivariate analysis

Variable	Category	p^*	OR (95%CI)
SARC-F		**0.008**	1.70 (1.15–2.51)
Age (years)		**0.007**	1.17 (1.04–1.32)
Gender	Male (ref)	< **0.001**	7.91 (2.48–25.2)
	Female		
BMI (kg/m^2)	≥ 25 (ref)	0.183	2.42 (0.66–8.90)
	< 25		

Abbreviation: BMI, body mass index; 95%CI, 95% confidence interval; OR, odds ratio; Ref, reference; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs, and falls.
*Logistic regression model and Wald test considering $p < 0.05$.

adjusted considering the fracture (yes or no) as a dependent variable and including as explanatory variables those that presented statistical significance in the univariate analysis (►**Table 7**).

The results of the multivariate model adjustment indicate that regardless of age, gender, and BMI, a higher SARC-F score is significantly associated with the probability of having fragility fracture. It is estimated that for each additional point in the SARC-F there is an increase of 70% in the chance of having fracture, regardless of age, gender, and BMI. It can also be said that regardless of SARC-F, gender, and BMI, with each additional year of age there is a 17% increase in the chance of having a fracture. Female patients, regardless of SARC-F, age, and BMI, have 7.91 times more chance of fracture than a male patient. Body mass index, in the presence of the variables SARC-F, age, and gender, is not significantly associated with the probability of having a fracture.

Discussion

Up to our current knowledge, this is the first study that directly comcants the SARC-F with the occurrence of fragility fractures, in view of a possible correlation between sarcopenia and increased risk of falls.

The most important finding of this study was that a higher SARC-F score leads to a significant increase in the risk of fragility fractures. Another finding, no less relevant, however already established in the literature, was that age interferes forcefully in the fracture index.[5,11]

According to the data presented in this study, age equal to or above 65 years of age presented an important correlation with the fracture index (sensitivity 82%, specificity 48%), and each year older, the individual's chance of suffering a fracture increases by 17%. It is a fact that the older the patient, the higher the incidence of osteoporosis, frailty, and consequently, the higher the risk of pathological fractures.[5,12,13]

According to Borgström, the female population suffers more fragility fractures, at a ratio of 2:1.[2] In the present study, it was observed that female patients were 7.91 times more likely to suffer a fracture compared to males. This fact may be related to menopause, low calcium intake, and lack of physical activity.[11,14]

The SARC-F is considered an important tool in the diagnosis of sarcopenia. The findings in this study showed that the SARC-F discriminated well between the occurrence or not of fracture, estimating that at each point more in the SARC-F, there was an increase of 70% in the chance of the patient having suffered a fracture, regardless of age, gender, and BMI. However, previous studies have not sought to establish a direct correlation between a higher result in the SARC-F score and the increased chance of the individual suffering fragility fracture, keeping the focus on the application questionnaire test as screening of sarcopenia.[9,15]

Of the items of the SARC-F score evaluated individually, it was observed that the items *difficulty to climb stairs* and *previous episodes of fall in the last year* were the ones most strongly associated with the occurrence of fractures. The presence of sarcopenia may increase twofold the chance of falls compared to non-sarcopenic individuals.[16]

In the present study, only 29 of the 100 patients evaluated had undergone some type of previous treatment for osteoporosis and sarcopenia, and most of them, that is, 22 patients, suffered some fragility fracture, even though they had undergone some treatment for this purpose previously. This finding may be attributed to incomplete or inadequate treatment for osteoporosis, as well as underdiagnosis of the disease. The low rate of patients who underwent some type of treatment for the prevention of fragility fractures is relevant; however, this finding is already reported in the literature, in which, especially in individuals over 75 years of age, osteoporosis is treated inadequately or is simply not treated.[17,18]

Regarding the location of fractures, no vertebral fracture was identified in the analyzed population, with distal radius fracture being the most prevalent, with 32 cases, followed by proximal femur fracture, with 18 cases. In a previous study, the site most frequently associated with osteoporotic fractures was the proximal femur, followed by fractures of the spine and only then the distal radius.[19]

In the present study, it was not possible to establish a correlation between BMI and the probability of fracture occurrence. The vast majority of individuals (n = 72) were overweight (BMI > 25 kg/m^2), and only a single patient with BMI < 18.5 kg/m^2 suffered distal radius fracture. According to Court-Brown et al.,[20] there is a positive correlation between underweight patients (BMI < 18.5 kg/m^2) and proximal femur fracture due to a higher incidence of sarcopenia in

these individuals, while the authors did not find a correlation between obesity and a higher risk of fractures.

The limitation of this study was the fact that the studied population belonged to the same institution, creating a homogeneous sample of the same socioeconomic profile and even similar life habits. The inclusion of participants from other institutions with different profiles could contribute to a better elucidation of the occurrence of fragility fractures in the general population.

Tools that can assist the physician in the identification of individuals who have a high potential to suffer fragility fracture, are certainly useful in clinical practice.[3] Through this research, it was possible to determine that the SARC-F presents a direct correlation with the risk of fractures, demonstrating that sarcopenia is a diagnosis that should be remembered by the physician in the care of elderly patients who have suffered fractures. Scores can guide the physician in requesting tests, prescribing medications, or referral to other specialties, but decision-making should be individualized and based on several factors, not only supported by calculations.

The development of a multicenter study with a more comprehensive age group of patients would be the suggested next step for future research for a solid finding of the relationship between SARC-F and the risk of fragility fractures.[21,22]

Conclusion

Our findings showed that there is a direct correlation between a higher SARC-F score and an increase in the chance of fragility fracture, especially in individuals over 65 years of age.

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Conflict of Interests
The authors declare that there is no conflict of interests.

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