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Prevalence of sarcopenia in a Danish geriatric out-patient population

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INTRODUCTION: The prevalence of sarcopenia varies extensively depending on the definitions and studied populations. The aim of this study was to assess the prevalence of sarcopenia in a Danish geriatric out-patient population using criteria from the European Working Group on Sarcopenia (EWGSOP).

METHODS: Patients referred to a geriatric outpatient-clinic were included. Using the EWGSOP's recommendations, Appendicular skeletal muscle mass (ASM), hand-grip strength (HGS) and gait speed (ten-meter walk (GS)) were assessed. Skeletal muscle mass index (SMI) was calculated by ASM/height² (kg/m²), and patients were classified with: no sarcopenia (normal SMI), pre-sarcopenia (reduced SMI, normal HGS and GS), sarcopenia (reduced SMI and reduced HGS or GS) or severe sarcopenia (reduced SMI, HGS and GS).

RESULTS: A total of 189 patients were screened, 80 were included. In all, 12 (15%) had severe sarcopenia, nine (11%) sarcopenia, eight (10%) pre-sarcopenia and 51 (64%) no sarcopenia. Mean age was significantly higher in the SARC-group (sarcopenia and severe sarcopenia) than in the NO-SARC-group (pre-sarcopenia and no sarcopenia) ($p = 0.009$), and BMI was significantly lower in the SARC-group ($p < 0.0001$). No difference was found in gender distribution ($p = 0.729$).

CONCLUSIONS: 26% of patients in a geriatric outpatient population had sarcopenia, which highlights that this is a common condition. Standard assessments can identify functional limitations, but not sarcopenia. The EWGSOP's recommendations are feasible, and we suggest that they should form part of the standard clinical comprehensive geriatric assessment.

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Sarcopenia is a multifactorial geriatric syndrome that is characterised by a progressive loss of skeletal muscle mass and associated with a high risk of physical disability, poor quality of life and increased mortality [1, 2]. Rosenberg introduced the concept of sarcopenia in 1988, and he stated that loss of lean body mass was the most significant age-related physical decline [3]. The first to propose a method for identifying sarcopenia, based on muscle mass, was Baumgartner and colleagues in the 1990s, using dual energy X-ray absorptiometry (DXA) [4]. Based on the criteria suggested by Baumgartner, the prevalence of sarcopenia was found to be

13-24% among older people > 70 years, and up to 50% in older people > 80 years, depending on the population studied [4-6]. These studies are from Northern America and Italy.

However, accumulating data have demonstrated that muscle mass may not always be linearly related to muscle function [7, 8]. Moreover, functional parameters such as gait speed and hand-grip strength are strong predictors of disability and survival [9]. Consequently, the original definition of sarcopenia as purely a loss of muscle mass has evolved into one that includes a loss of both muscle mass and muscle function [10, 11]. The first steps towards a practical clinical definition and consensus diagnostic criteria for age-related sarcopenia combining muscle mass with muscle function and/or muscle strength were taken in 2009 by the International Working Group on Sarcopenia (IWGS) and in 2010 by the European Working Group on Sarcopenia (EWGSOP) [10, 11]. The latter group suggests that the comprehensive geriatric assessment (CGA) (a multidimensional interdisciplinary diagnostic process focused on determining a frail older person's medical, psychological and functional capability in order to develop a coordinated and integrated plan for treatment and long-term follow-up) should include assessment of sarcopenia in terms of measurements of muscle mass, hand-grip strength and gait speed [11].

Based on outcomes, sarcopenia is categorised as: 1) pre-sarcopenia (low muscle mass, normal function and normal strength), 2) sarcopenia (low muscle mass and either low strength or low function), or 3) severe sarcopenia (low muscle mass and low strength and low

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Hand-grip strength testing.



Gait speed testing.

function) [11]. Despite these initiatives and the severe consequences of sarcopenia, a widespread clinical use of the concept is still lacking, and the European algorithm for assessing sarcopenia has not yet been fully implemented in geriatric clinical practice in Denmark.

The objective of this cross-sectional study was therefore to assess the prevalence of sarcopenia in a Danish geriatric out-patient population based on the recommendations from the EWGSOP. In addition, the purpose was to describe the association between sarcopenia and age, gender, BMI and prevalence of chronic diseases in the study population. Furthermore, we wanted to evaluate if the sarcopenia assessment based on these recommendations is superior to currently used geriatric tests for muscle function and muscle strength for identification of patients with sarcopenia.

METHODS

The study population consisted solely of patients recruited from a geriatric out-patient clinic (the Geriatric Section, Medical Department, Rigshospitalet – Glostrup)

who were consecutively assessed for inclusion in the study from June 2014 through May 2015. Patients were referred to the geriatric out-patient clinic for fall assessment, geriatric assessment or follow-up after admission from wards at Rigshospitalet – Glostrup, other hospitals, or general practitioners. There was no recruitment from the emergency department. All patients provided their written, informed consent to participate in the extended assessment programme. The local ethical committee approved the study (H-3-2013-124).

The exclusion criteria were: age < 65 years, severe communicative problems, moderate-severe dementia and no independent walking. **Figure 1** presents a flow chart of the inclusion process. Data on the included patients were collected, including demographics, nutritional status (BMI) and comorbidity.

Dual energy X-ray absorptiometry

Appendicular skeletal muscle mass (ASM) was defined as the sum of soft lean tissue masses for arms and legs, assuming that all non-fat and none-bone are skeletal muscle. ASM was determined by DXA, using a Lunar iDXA scanner (GE Medical Systems, Madison, WI, USA) at the Department of Clinical Physiology, Nuclear Medicine & PET, Rigshospitalet – Glostrup. The Skeletal Muscle Mass Index (SMI) was defined by $ASM/height^2$ (kg/m^2) with cut-off values similar to those reported by Newmann and colleagues (men: < 7.23 kg/m^2 , women: < 5.67 kg/m^2) [12].

Hand-grip strength

Muscle strength was determined by hand-grip strength with a hand grip dynamometer (DHD-1 Digital Hand Dynamometer, Saehan 2012) ad modum the Southampton Protocol [13]. In brief, the patient was in a seated position with the arm supported by a horizontal surface. The best of three trials was used for the dominating hand. The cut-off values suggested by Lauretani and colleagues were used (men: < 30 kg, women: < 20 kg) [14].

Gait speed

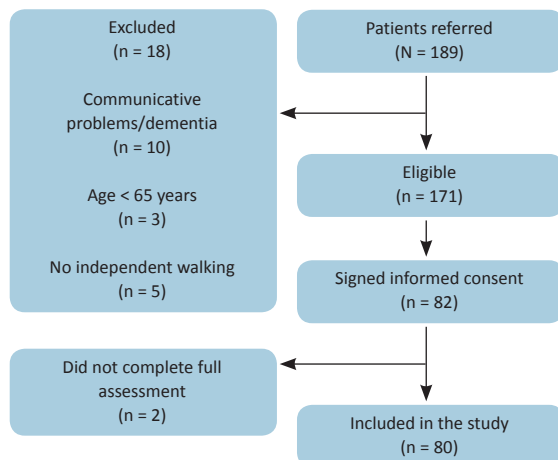
Muscle function was measured by testing gait speed using the ten-meter walk test with a cut-off value of < 0.8 m/sec. for both men and women [15].

Sarcopenia was classified in accordance with the EWGSOP criteria [11]:

- No sarcopenia: normal muscle mass
- Pre-sarcopenia: low muscle mass but normal muscle strength and normal muscle function
- Sarcopenia: low muscle mass and either low muscle strength or low muscle function
- Severe sarcopenia: low muscle mass, low muscle strength and low muscle function.

FIGURE 1

Flow chart of the inclusion process.



In addition, the patients were tested with chair stand test [16] and Timed Up and Go test [17] as a part of standard CGA in the geriatric outpatient clinic. Cut-off values: Timed Up and Go: > 12 sec. and chair stand in accordance with the patient's age and gender [16]. The physical tests were performed by trained physiotherapists at the outpatient clinic Geriatric Section, Medical Department, Rigshospitalet – Glostrup.

Statistics

SAS Enterprise Guide 7.1 was used for the statistical analyses. Unless otherwise stated, continual variables are presented with mean \pm standard deviation and categorical variables are presented with numbers and percentage in the presentation of group characteristics. Unpaired t-test, chi-squared test and Fisher's exact test were used as appropriate in the comparison of the groups. To overcome confounding differences between groups, we performed a multivariate logistic regression analysis with sarcopenia status as the dependent variable and age > 80 years, low BMI (BMI \leq 20.5 kg/m²) and gender as the covariates. Due to limited sample size, the sarcopenia groups were pooled into two: the no sarcopenia group (no sarcopenia + pre-sarcopenia) and the sarcopenia group (sarcopenia + severe sarcopenia).

Trial registration: not relevant.

RESULTS

Participants

A total of 189 patients were screened for inclusion and 18 of these were excluded according to the exclusion criteria. In all, 82 patients signed an informed consent form and were included, and 80 patients completed the full study (Figure 1).

Demographic baseline characteristics, functional ability and results of muscle mass measurements are presented in **Table 1**. The mean age in the study population was 79 years (65-94 years). Most of the participants were women (65%), and the majority of the patients were referred for fall assessment (78%). A low BMI was found in 20% of the patients > 80 years and in 9% among patients < 80 years.

Prevalence of sarcopenia based on the European Working Group on Sarcopenia criteria

When classifying the patients in accordance with the criteria from the EWGSOP, 12 (15%) were found to have severe sarcopenia, nine (11%) sarcopenia, eight (10%) pre-sarcopenia and 51 (64%) no sarcopenia. In total, 21 (26%) had clinical sarcopenia, i.e. sarcopenia and severe sarcopenia, whereas 59 (74%) did not have sarcopenia. The classification of sarcopenia in comparison with patient characteristics is shown in **Table 2**.

The mean age was significantly higher in the group with sarcopenia and severe sarcopenia than in the group without sarcopenia ($p = 0.009$). No difference was found in gender distribution ($p = 0.729$) (Table 2). Contrary to our expectations, the prevalence of chronic diseases such as diabetes and polyneuropathy was higher in the group without sarcopenia than in the group that had sarcopenia (Table 2).

A multivariate logistic regression analysis was performed with clinical sarcopenia (sarcopenia and severe sarcopenia) as the dependent variable and the following covariates in the model: age > 80 years, low BMI and fe-

TABLE 1

Demographic characteristics and data on muscle mass and functional ability.

	All (N = 80)	Women (n = 52)	Men (n = 28)
Age, mean \pm SD (range), yrs	79 \pm 6.6 (65-94)	80 \pm 6.9 (65-92)	79 \pm 6.2 (68-94)
<i>Referral type, n (%)</i>			
Fall assessment	62 (78)	41 (79)	21 (75)
Geriatric assessment	18 (23)	11 (21)	7 (25)
Follow-up after admission, n (%)	13 (16)	7 (14)	6 (21)
<i>Comorbidity, n (%)</i>			
Diabetes	19 (24)	12 (23)	7 (25)
Neurological disease	5(6)	4 (8)	1 (4)
Uraemia	10 (13)	7 (14)	3 (11)
Heart disease	7 (9)	3 (6)	4 (14)
Parkinson's disease	2 (3)	2 (4)	0
Polyneuropathy	28 (35)	15 (29)	13 (46)
Stroke	25 (31)	15 (29)	10 (36)
<i>BMI</i>			
Low BMI ^a , n (%)	11 (14)	6 (12)	5 (18)
BMI, mean \pm SD (range), kg/m ²	26.2 \pm 5.1 (15-42)	26.3 \pm 5.3 (15-40)	26 \pm 4.8 (18-42)
<i>TUG</i>			
Pathological TUG, n (%)	34 (47)	25 (48)	9 (32)
TUG, mean \pm SD (range), sec.	15.4 \pm 11.4 (6-90)	16.5 \pm 13.1 (9-90)	13.3 \pm 7 (6-32)
Pathological CS, n (%)	45 (62)	28 (54)	17 (61)
<i>GS</i>			
Pathological GS, n (%)	23 (29)	15 (29)	8 (29)
GS, mean \pm SD (range), m/sec.	1,1 (0,1-3) (0,5)	1,0 (0,1-2) (0,4)	1,2 (0,2-3) (0,5)
<i>HGS</i>			
Pathological HGS, n (%)	42 (53)	29 (56)	13 (46)
HGS, mean \pm SD (range), kg	23.8 \pm 7.9 (9-46)	19.6 \pm 4.7 (9-30)	31.5 \pm 6.8 (16-46)
<i>SMI</i>			
Pathological SMI, n (%)	29 (36)	17 (33)	12 (43)
SMI, mean \pm SD (range), kg/m ²	6.7 \pm 1.2 (4-12)	6.7 \pm 1.3 (4-12)	6.9 \pm 1.1 (5-9)

CS = chair stand test; GS = gait speed test; HGS = hand-grip strength test; SD = standard deviation; SMI = skeletal muscle mass index; TUG = Timed Up and Go test.
a) \leq 20.5 kg/m².

male gender. The results showed that in this study, high age and poor nutritional status were associated with a higher risk of sarcopenia, whereas female gender was not (Table 3).

Muscle strength and functional performance

Low muscle strength as measured by hand-grip strength was found in 53% and according to the chair stand test in 62%. Low muscle function measured by gait speed and Timed Up and Go was present in 29% and 47% patients, respectively. A pathological muscle mass was found in 36% of the patients. The number of patients with a low muscle strength as measured by the chair stand test was 14 (67%) in the sarcopenia group and 31 (53%) in the group without sarcopenia; whereas measured by hand-grip strength, it was 20 (95%) in the sarcopenia group versus 22 (37%) in the group without sarcopenia.

Low muscle function measured by the Timed Up and Go test was found in 13 (62%) in the group with sarcopenia and in 21 (36%) in the group without sarcopenia; and by gait speed in 13 (62%) in the sarcopenia group versus ten (17%) in the group without sarcopenia. The results of the chair stand and Timed Up and Go are shown in Table 2.

The negative predictive value was 89% for the chair stand test and 90% for Timed Up and Go, indicating that a patient with a normal test result has a very low probability of having sarcopenia (Table 3). The low positive predictive values for the chair stand test (31%) and the Timed Up and Go test (38%) indicate that these tests cannot be used as predictive assessment tools for sarcopenia (Table 3).

DISCUSSION

The aim of the present study was to assess the prevalence of clinical sarcopenia in a Danish geriatric outpatient population based on the EWGSOP recommendations. To the best of the authors' knowledge, this is the first study to do so.

In this study population, the prevalence of clinical sarcopenia (sarcopenia + severe sarcopenia) was 26%, which is in line with data from similar populations [6, 10, 18, 19]. Comparable studies have found sarcopenia to fall in the 4-29% range [10]. A recent study from The Netherlands demonstrated prevalence rates for sarcopenia in a geriatric out-patient population of 17-22% [18].

One of the strengths of this study was that, once included, 98% of the patients completed the assessment programme; yet, the participation rate was only 48%. A plausible explanation could be that the frailest patients were the ones who declined to participate, thereby making the results less representative for the overall population in the geriatric outpatient clinic. This combined with the small study size may restrict the generalisability of the results.

Furthermore, this study underlines the difficulty of distinguishing if functional limitations are due to sarcopenia or other conditions. A relatively high percentage of the tested patients had functional limitations in terms of low muscle strength and low muscle function without low muscle mass. As most of the patients were referred for fall assessment, functional disability due to, e.g., balance disturbances may interfere with functional disability due to low muscle function. Fear of falling and lack of motivation may be other possible confounding elements. This may have entailed an overestimation of the prevalence of clinical sarcopenia when using the EWGSOP definition in the present population. Another aspect is the American reference material on which the clinical diagnosis of sarcopenia is based when the

TABLE 2

Sarcopenia classification in comparison with patient characteristics.

	NOSARC-group (N = 59)	SARC-group (N = 21)	p-value
Age, mean \pm SD, yrs	78.1 \pm 6.4	82.5 \pm 6.3	0.009 ^c
Age \geq 80 yrs, n/N (%)	20/59 (33.9)	15/21 (71.4)	0.003 ^d
Gender, n/N (%)			0.729 ^d
Male	20/59 (33.9)	8/21 (38.1)	
Female	39/59 (66.1)	13/21 (61.9)	
<i>BMI</i>			
BMI, mean \pm SD, kg/m ²	27.8 \pm 4.7	21.7 \pm 3.1	< 0.0001 ^c
Low BMI ^a , n (%)	2/59 (3.4)	9/21 (42.9)	< 0.0001 ^e
<i>Chronic diseases, n/N (%)</i>			
Diabetes	19/59 (32.2)	0/21	0.002 ^e
Neurological disease	5/59 (8.5)	0/21	0.318 ^e
Uraemia	8/59 (13.6)	2/21 (9.5)	1.000 ^e
Heart disease	4/59 (6.8)	3/21 (14.3)	0.371 ^e
Parkinson	1/59 (1.7)	1/21 (4.8)	0.459 ^e
Polyneuropathy	25/59 (42.4)	3/21 (14.3)	0.021 ^d
Stroke	20/59 (33.9)	5/21 (23.8)	0.392 ^d
<i>Pathological test values, n/N (%)</i>			
TUG ^b	21/56 (38)	13/17 (76)	0.0048 ^d
CS ^a	31/56 (55)	14/17 (82)	0.045 ^d
GS	10/59 (17)	13/21 (62)	< 0.0001 ^d
HGS	22/59 (37)	20/21 (95)	< 0.0001 ^d

CS = chair stand test; GS = gait speed test; HGS = hand-grip strength test; NOSARC = no sarcopenia + pre-sarcopenia; SARC = sarcopenia + severe sarcopenia; SD = standard deviation; TUG = Timed Up and Go test.

a) \leq 20.5 kg/m².

b) 7 missing values for TUG and CS.

c) Unpaired t-test.

d) Chi-squared test.

e) Fisher's exact test.

EWGSOP recommendations are used. As far as we know, a European reference material for muscle mass is still lacking.

In this study, high age and poor nutritional status were found to be associated with sarcopenia, which is consistent with previous findings [4, 6, 11, 18]. Remarkably, though, the present study could not demonstrate an association between sarcopenia and chronic diseases, which may be due to our small sample size and/or selection bias if the frailest patients with chronic diseases and sarcopenia were the ones most likely to decline participation in the study.

Another aim of the present study was to evaluate if the EWGSOP-recommended assessment would be superior to currently used geriatric tests for muscle function and muscle strength in identifying geriatric patients with sarcopenia. Calculating predictive values of the chair stand and Timed Up and Go show that these tests are not suitable for identifying patients with sarcopenia.

A larger number of patients were found with pathological chair stand and Timed Up and Go results than with sarcopenia and/or severe sarcopenia. Common conditions among geriatric patients such as balance disturbances, vestibular dysfunction, orthostatic intolerance and fear may interfere with the test results of the functional tests, since both the chair stand and Timed Up and Go demand a certain degree of standing and walking balance. This may result in some pathological test findings which are not due to sarcopenia. Consequently, the present findings underline that the chair stand and Timed Up and Go may be useful measurements to identify functional limitation and need of physical training in geriatric patients, but it is important to add an assessment of muscle mass (SMI), hand-grip strength and gait speed to the comprehensive clinical geriatric assessment when aiming to identify sarcopenia.

Effective diagnosis of low muscle mass and parallel impairments in muscle function is crucial in order to ini-

tiate early targeted treatments to prevent falls, fractures and disability, and ultimately lead to an improved quality of life, and it seems important to gain more experience and knowledge about the various sarcopenia variables and cutoff values in different populations.

CONCLUSIONS

Based on the EWGSOP criteria, 26% of the patients in the present study had either sarcopenia or severe sarcopenia. This is in line with previous findings [4, 6, 11, 18]. In contrast, there was no association between sarcopenia and chronic disease, but high age and poor nutritional status were found to be associated with sarcopenia.

Assessment of sarcopenia using the EWGSOP diagnostic method is feasible in a geriatric outpatient population as part of the comprehensive geriatric assessment. The currently used geriatric tests for muscle function and muscle strength – chair stand and Timed Up and Go – cannot identify patients with sarcopenia.

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TABLE 3

	NOSARC-group, n ₁	SARC-group, n ₂	Positive predictive value for the test, %	Negative predictive value for the test, %
<i>Pathological test value</i>				
CS	31	14	$n_2/(n_1 + n_2) = 31$	–
TUG	21	13	$n_2/(n_1 + n_2) = 38$	–
<i>Normal test value</i>				
CS	25	3	–	$n_1/(n_1 + n_2) = 89$
TUG	35	4	–	$n_1/(n_1 + n_2) = 90$

Positive and negative predictive values for the chair stand test and the Timed Up and Go test^a.

CS = chair stand test; NOSARC = no sarcopenia + pre-sarcopenia; SARC = sarcopenia + severe sarcopenia; TUG = Timed Up and Go test.

a) 7 missing values for CS and TUG.

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