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ORIGINAL INVESTIGATION

Prevalence and clinical correlates of sarcopenia in institutionalized older people: cross-sectional study of a nursing home population

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Background & aims. Sarcopenia is a common condition among institutionalized older people which leads to increased risk of adverse outcomes such as disability and death. We investigated the prevalence and clinical correlates of sarcopenia in older institutionalized adults in Italy, while also evaluating the interchangeability and adequacy of two definitions of sarcopenia (EWGSOP and FNIH) for this geriatric setting.
Methods. Cross-sectional analysis of 97 participants enrolled in a nursing home facility in Italy. Since 97% of the study subjects resulted either unable to walk or "slow walkers", we assessed sarcopenia presence ignoring the walking speed criterion: sarcopenia was assessed as low appendicular skeletal mass index plus low grip strength (EWGSOP criteria) and as weakness plus low lean mass (FNIH criteria). Skeletal muscle mass was estimated using bioimpendance analysis.
Results. In this population of 97 institutionalized older people (age 83.2 ± 9.4 years, women 73.2%), according to both EWGSOP and FNIH criteria 13 participants (13.4%) were identified as affected by sarcopenia; however, only 5 subjects were identified as sarcopenic according to both definitions simultaneously. The prevalence of sarcopenia was directly correlated with male sex and comorbidity level, while being inversely correlated with Body Mass Index.
Conclusions. According to EWGSOP and FNIH criteria, prevalence of sarcopenia is significant among institutionalized older people, and it's strongly related to male sex, BMI and comorbidity level. EWGSOP and FNIH criteria identified as sarcopenic different individuals and therefore cannot be used interchangeably. Assessment of walking speed might be unfeasible in institutionalized older subjects.

Key words: Sarcopenia, Prevalence, Institutionalized older people, Nursing Home

INTRODUCTION

The aging process is associated with the loss of muscle mass, resulting in a loss of muscle strength and function that has been referred to as sarcopenia [1 2]. Sarcopenia as a geriatric syndrome leads to the limitation of physical performance and increases the risk of adverse outcomes including mobility limitation, disability, hospitalization, low quality of life, and death [3 4].
In 2014 the International Sarcopenia Initiative published a systematic review [5] reporting the prevalence of sarcopenia estimated by several studies performed in various geriatric settings: if assessed according to European Working Group on Sarcopenia in Older People (EWGSOP) criteria [4], the prevalence of sarcopenia in community-dwelling populations ranges from 1 to 29%; the prevalence of sarcopenia is even more substantial in institutionalized populations: from 14 to 68% among male subjects and from 14 to 33% among female subjects.
Recently, the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project has proposed new

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diagnostic criteria for the assessment of sarcopenia based on the analysis of 9 population studies conducted on a 26625 community-dwelling older adults [6], assessing the role of weakness (defined as low muscle strength) and low muscle mass as key components of the sarcopenia phenotype.

Despite sarcopenia has been found to be an extremely common condition among institutionalized older people [7 8], currently the amount of data regarding this geriatric setting is relatively scarce, due to the difficulties often encountered while analyzing this population [7]: first, institutionalized subjects are often affected by several medical conditions and cognitive impairment, which may hinder the reliability of some diagnostic tests; second, Dual-Energy X-ray Absorptiometry (DXA), which is the reference technique for the assessment of muscular mass, and bioimpendance analysis (BIA), an easily accessible and portable DXA alternative [9], are not usually available in nursing homes.

The estimated prevalence of sarcopenia among different studies performed on institutionalized populations is extremely heterogeneous due to the lack of a common consensus regarding the diagnostic criteria and the methods used to assess sarcopenia criteria (muscle mass, muscle strength and physical performance). The majority of the studies performed on institutionalized populations assessed sarcopenia according to EWGSOP criteria, whereas studies on prevalence of sarcopenia according to the FNIH diagnostic criteria are still lacking in this population.

This study was designed to investigate the prevalence and clinical correlates of sarcopenia in older institutionalized adults in Italy, and to compare the data obtained using two different definitions of sarcopenia, the EWGSOP and FNIH criteria. We investigated the interchangeability and the discrepancies between the two definitions; we also evaluated the adequacy of the current diagnostics criteria when applied to a population with high prevalence of physical limitation and cognitive impairment.

METHODS

Study population

This cross-sectional study was performed on the residents of "Centro Servizi Anziani di Monselice", a structure that is both a Retirement and Nursing Home, located in Monselice, Veneto, Italy.

As of April 2017, the structure hosted a total of 158 older people.

Participants' data were collected through the consultation of the medical records provided by the structure and a standardized dedicated questionnaire including demographic characteristics, functional status, cognitive status, mood assessment, medication use and incident and prevalent medical conditions.

Exclusion criteria were: inability to undergo BIA (leg edema, pacemaker, joint prosthesis, bedridden, refused); inability to perform the grip strength test (joint prosthesis, severe pain to the upper limbs, refused); severe cognitive impairment which precluded the complete cooperation during the questionnaire filling or the tests execution; inability or refusal to grant approval for the inclusion in this study; new entries with inadequate anamnestic and clinical documentation.

Prevalence of sarcopenia and of its clinical correlates was therefore assessed in 97 subjects, 26 males and 71 females.

Assessment of sarcopenia

According to EWGSOP [4] criteria, sarcopenia was defined as presence of low muscle mass plus low muscle strength and/or low walking speed. As requested by FNIH criteria [6,] sarcopenia was defined as "weakness and low lean mass" or "slowness with weakness and low lean mass".

Muscle mass was measured by BIA using a Quantum/S Bioelectrical Body Composition Analyzer (Akern Srl, Florence, Italy). Whole-body BIA measurements were taken between the right wrist and ankle with the subject in a supine position, when possible. Appendicular Lean Mass (ALM) was calculated using the following equation of Scafoglieri and colleagues [10]: $ALM_{HOLOGIC}(kg) = 4,957 + (0,196 \times height^2/resistance) + (0.060 \times weight) - (2.554 \times sex)$, where height is measured in centimeters; resistance is measured in ohms; weight is measured in kilograms; for gender, men = 0 and women = 1. Appendicular lean mass (kg) was converted to appendicular skeletal muscle index (ASMI) standardizing by meters squared (ALM/height^2) and Body Mass Index (ALM/BMI) as requested by EWGSOP and FNIH criteria respectively. As claimed by EWGSOP criteria [4], low appendicular muscle mass was classified as ASMI less than 7.23 kg/m^2 in men and 5.67 kg/m^2 in women; according to FNIH [6], low appendicular muscle mass was classified as a ALM/BMI ratio lower than 0.789 and 0.512 in men and women, respectively.

Muscle strength was assessed by grip strength (GS), measured using a hand-held dynamometer (JAMAR hand dynamometer, Sammons Preston Inc, Bolingbrook, Illinois, USA). Two trials with the dominant hand were performed, when possible, and the highest value was used in the analysis [11]. According to EWGSOP [4 12], Body mass index (BMI) - adjusted values were used as a cutoff point to identify low muscle strength (men: BMI $\leq$ 24 kg/m^2 GS $\leq$ 29 kg, BMI 24.1-28 kg/m^2 GS $\leq$ 30 kg, BMI $\geq$ 28 kg/m^2 GS $\leq$ 32 kg;

women: BMI ≤ 23 kg/m^2 GS ≤ 17 kg, BMI 23.1-26 kg/m^2 GS ≤ 17.3 kg, BMI 26.1-29 kg/m^2 GS ≤ 18 kg, BMI ≥ 29 kg/m^2 GS ≤ 21 kg) while, in line with FNIH criteria [6], crude values were used (men: GS < 26 kg; women: GS < 16 kg).

Usual walking speed (m/s) on a 4-m course was used as an objective measure of physical performance; speed lower than 0.8 m/s identified participants with low physical performance ("slow walkers") [4 6]. Thirty-seven subjects did not perform the walking test; since all of them were unable to walk or had an extremely high risk of fall, we included them among those who performed the test and were classified as "slow walkers". Since more than 97% of the subjects (94 out of 97) resulted "slow walkers", we decided to ignore the walking speed criterion included in both sarcopenia definitions; this decision was supported by the result of a previous study [12] suggesting that low walking speed might not be an essential criterion for the diagnosis of sarcopenia.

Covariates

Sociodemographic characteristics. Sociodemographic variables (Age, gender, smoking habit, alcohol consumption, education) were assessed through survey questions.

Functional and mobility status. Functional status in basic activities of daily living (ADLs) and mobility were assessed trough a modified Barthel Index (BI) [13], which has been adapted to be paired with S.Va.M.A score for the evaluation of the elderly in institutionalized settings. Functional status in basic ADL was measured according to the participants' difficulty in performing each of six activities: getting in and out of a bed, bathing, dressing, eating, continence, and using the toilet. The score for functional status ranges between 0 (independent) and 60 (dependent); a score ≥ 15 identified functional disability, whereas a score ≥ 50 identified severe functional disability. Mobility status was measured according to the participants' difficulty in performing each of five tasks: walking, wheelchair use, moving from bed-chair to wheelchair, going up and down stairs. The score for functional status ranges between 0 (independent) and 40 (dependent); a score ≥ 15 identified mobility impairment, whereas a score ≥ 30 identified severe mobility impairment.

Cognitive and mood status. Cognitive functioning was explored using the Mini Mental State Examination (MMSE), with scores less than 24 suggesting cognitive impairment. Mood status was assessed with the 15 item version of the Geriatric Depression Scale (GDS), with scores more than 5 out of 15 suggesting the presence of depressive symptoms [14].

Specific medical conditions and comorbidity. The baseline prevalence of specific medical conditions was established using standardized criteria that utilized information gathered from the structure's clinical records. Comorbidity levels were assessed using the Cumulative Illness Rating Scale (CIRS) calculating for each participants CIRS severity index and CIRS comorbidity index [15].

Statistical analysis

For descriptive purpose, baseline characteristics of the study population were compared according to presence or absence of sarcopenia, using a t-student test for continuous variables with normal distribution, the nonparametric Wilcoxon Mann-Witney test for not normally distributed continuous variables and the Fisher-exact test for categorical variables. To identify factors independently associated with the two sarcopenia phenotype we utilized univariate logistic regression analysis; factors resulted independently related to sarcopenia was then included in multivariate logistic regression models for each sarcopenia definition.

All analyses were performed using Stata 13.0 for Windows (StataCorp, College Station, TX).

RESULTS

General characteristic of 97 participants (mean age 83.2 ± 9.4, 73.2% women) according to the presence of sarcopenia are presented in Table I.

13 (13.4%) participants were identified as sarcopenic using each sarcopenia criteria separately; between them, only 5 subjects were simultaneously identified as sarcopenic according to both definitions (Fig. 1).

Sarcopenic participants were more likely to be male (Fig. 2): 26.9% and 30.8% of the male participants were identified as sarcopenic according to EWGSOP and FNIH criteria respectively, while only 8.5% (EWGSOP) and 7% (FNIH) of the female subjects were identified as sarcopenic. Prevalence of sarcopenia increased in subjects included in the 80-89 years range (18.8% EWGSOP, 21.9% FNIH) compared to younger subjects (13.5% EWGSOP, 8.1% FNIH); lower sarcopenia prevalence was conversely found in subjects 90 years old or older (7.1% EWGSOP, 10.7% FNIH) (data not shown).

No significant difference was found between sarcopenic and not sarcopenic participants, defined by EWGSOP criteria, in both severe functional disability and severe mobility impairment prevalence; conversely we found a substantial although not statistically significant difference in severe functional disability when sarcopenia was defined according to FNIH criteria (46.2% and 23.8% in sarcopenic and not sarcopenic participant respectively).

Figure 3 shows BMI distribution in sarcopenic subjects: the vast majority of sarcopenic subjects, independently by the sarcopenia definition used, were included in the

Table I. Selected general characteristics of study participants according to definition and presence of sarcopenia.

	EWGSOP		P	FNIH		P
	No Sarcopenia	Sarcopenia		No sarcopenia	Sarcopenia	
N	84 (86.6%)	13 (13.4%)	0.612	84 (86.6%)	13 (13.4%)	0.782
Male (%)	22.6	53.8	0.018	21.4	61.5	0.002
Age (years)	83.3 ± 9.9	82 ± 6.1	0.508	83.0 ± 9.7	84.5 ± 7.5	0.597
Education (≥ 5 years, %)	67.9	76.9	0.510	71.4	53.9	0.202
Smokers (%) Never Former/current	 69.1 30.9	 53.9 46.1	0.278	 69.1 30.9	 53.9 46.1	0.278
BMI (kg/m^2)	27.9 ± 4.5	23.1 ± 3.2	0.001	27.2 ± 4.9	27.7 ± 2.2	0.502
Weight loss (≥ 10% in the last 6 months)	16.7	23.1	0.572	16.7	23.1	0.572
ASMI (kg/m^2)	6.7 ± 0.9	6.0 ± 0.7	0.009	6.5 ± 0.9	6.8 ± 0.77	0.424
ALM/BMI	0.6 ± 0.1	0.7 ± 0.1	0.020	0.6 ± 0.1	0.6 ± 0.1	0.723
Grip strength (kg)	22.1 ± 7.8	17.8 ± 4.6	0.009	22.1 ± 7.8	17.7 ± 4.8	0.009
4-m walking speed (n = 60, m/s)	0.5 ± 0.2	0.4 ± 0.1	0.214	0.5 ± 0.2	0.5 ± 0.1	0.623
Severe functional disability (%)	26.2	30.8	0.742	23.8	46.2	0.103
Severe mobility impairment (%)	36.9	30.8	0.765	35.7	38.5	1.000
CIRS severity (median, IQR)	1.3 [1-1.5]	1.4 [1-1.6]	0.391	1.3 [1-1.5]	1.5 [1-1.6]	0.402
CIRS comorbidity (median, IQR)	2 [1-3.5]	4 [1-4]	0.167	2 [1-3.5]	4 [2-4]	0.044
Cognitive impairment (n = 95, %)	60.2	58.3	0.900	57.3	76.9	0.180
Number of medications	6.5 ± 3.0	5.9 ± 2.2	0.232	6.5 ± 3.0	5.8 ± 2.2	0.412

BMI = body mass index; ASMI = appendicular skeletal muscle index; ALM = appendicular lean mass; CIRS = cumulative illness rating scale; IQR = interquartile range. Data are means ± *SD* unless otherwise indicated.

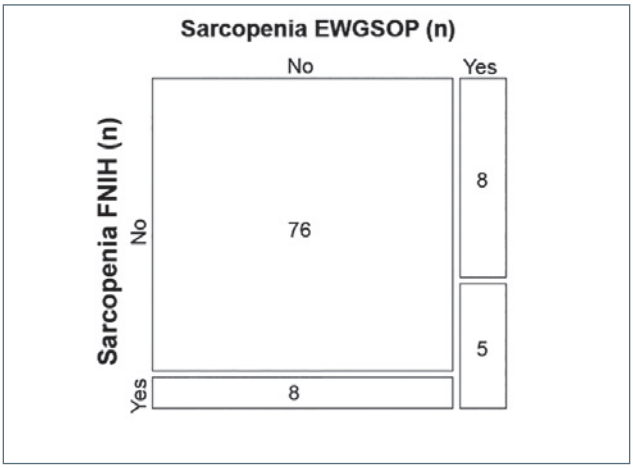

Figure 1. Prevalence of sarcopenia according to sarcopenia definition. Individually, both EWGSOP and FNIH criteria identified 13 participants as sarcopenic; only 5 subjects were identified as sarcopenic according to both definitions simultaneously.

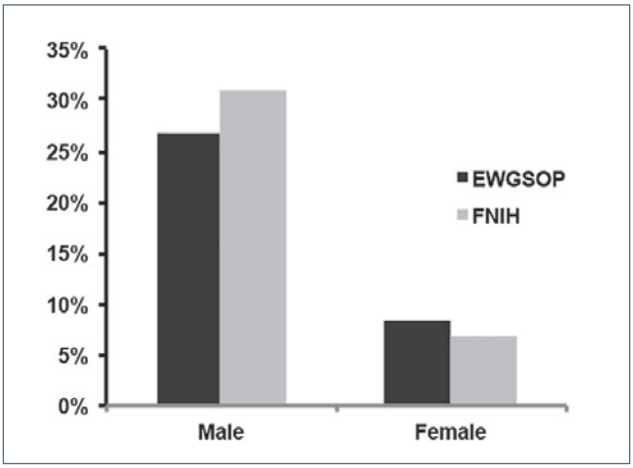

Figure 2. Prevalence of sarcopenia according to sex and definition of sarcopenia. Both EWGSOP and FNIH criteria found the prevalence of sarcopenia to be substantially higher in male subjects compared to female subjects.

21-29kg/m^2 BMI range (84.6% EWGSOP, 92.3% FNIH). Taking into account EWGSOP criteria, 15.4% of the sarcopenic subjects had BMI lower than 21kg/m^2, while none of them could be defined as obese (BMI > 30 kg/m^2); conversely, according to FNIH criteria, none of the sarcopenic subjects had BMI lower than 21kg/m^2, while 7.7% of them had BMI > 30kg/m^2.

No difference was found in prevalence of cognitive impairment between sarcopenic and not sarcopenic subject identified by EWGSOP definition. Conversely,

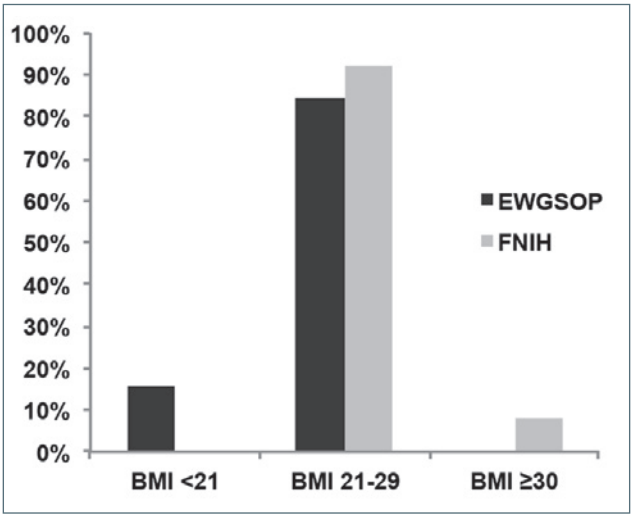

Figure 3. Body Mass Index (BMI) ranges distribution in sarcopenic subjects. Most of the sarcopenic subjects fall into the 21-29 BMI range. None of the subjects identified as sarcopenic by EWGSOP criteria is obese, while none of the subjects identified as sarcopenic by FNIH criteria is malnourished.

according to FNIH criteria cognitive impairment tend to be more common in sarcopenic subject (76.9% and 57.3% for sarcopenic and not sarcopenic participants respectively).

The average number of medications assumed was found to be marginally lower in the sarcopenic subjects compared to not sarcopenic subjects using both definition.

In univariate logistic regression analysis male sex was significantly associated with sarcopenia prevalence using both sarcopenia definition (OR:12.14; 95% CI: 2.31-63.67 for EWGSOP and OR:5.52; 95% CI: 1.54-19.88 for FNIH criteria). Considering EWGSOP criteria, we found a decreased probability of being sarcopenic with increasing BMI (OR: 0.64; 95% CI: 0.50-0.82). According to FNIH definition, subjects with higher CIRS comorbidity score were more likely to be sarcopenic (OR: 1.48; 95% CI: 1.02-2.16). Using the same criteria, an increased probability of being sarcopenic was also found for participants with severe functional disability although this relationship was of borderline statistical significance (OR 2.74; 95% CI: 0.83-9.11) (Tab. II).

Multivariable analysis confirmed an independent and significant association between male sex and sarcopenia defined according to both criteria (OR 95% 12.1; 95%CI 2.3-63.7 for EWGSOP and OR 5.52; 95% CI 1.54-19.9 for FNIH). Inverse association between BMI and probability of being sarcopenic (EWGSOP definition) was also confirmed (OR 0.64; 95% CI 0.50-0.82) as well as an increased risk of being sarcopenic (FNIH definition) with higher CIRS comorbidity score (OR 1.48; 95% CI 1.02-2.16).

DISCUSSION

Our study suggest that, among a population of institutionalized older people, sarcopenia, defined by either EWGSOP or FNIH criteria, is a common condition. Male sex was significantly associated with sarcopenia using both definition; higher BMI was inversely associated with sarcopenia prevalence defined by EWGSOP criteria whereas level of comorbidity was directly associated with sarcopenia defined according to FNIH criteria.

The estimated prevalence of sarcopenia from this study is in line, although somehow lower, with the values reported in the 2014 International Sarcopenia Initiative review [5], according to which the prevalence of sarcopenia in institutionalized older people ranges between 14 and 33%; however, other studies [7 8] reported a significantly higher prevalence of sarcopenia in nursing home settings (as high as 40%). Difference between our data and previous report may be justified by the changes we applied to the diagnostic criteria of sarcopenia. First, we decided to assess muscle mass utilizing the Appendicular Skeletal Muscle Mass Index, as opposed to the Skeletal Muscle Mass Index, since Appendicular Lean Mass has been found to be the more specific in evaluating the skeletal muscle mass of the elderly [6 16]. Second, we ignored the walking speed criterion since 37% of the participants were not able to perform the 4-m walking test because of the inability to walk or coexisting medical conditions that contraindicated the test administration, and 97% of the study subjects resulted "slow walkers", hindering the effectiveness of walking speed as a diagnostic criterion. Our decision was corroborated by the results of a previous study [12] which reported that the assessment of only muscle weakness in addition to low muscle mass provided similar predictive value compared to the original algorithm of the EWGSOP sarcopenia definition in terms of incident disability, risk of hospitalization and mortality, suggesting that low walking speed might not be an essential criterion for the diagnosis of sarcopenia.

In agreement with previous reports in similar settings [7 8], our findings suggest that sarcopenia is significantly more common among men compared to women.

According to EWGSOP criteria, increasing BMI was inversely related to sarcopenia presence and, in our sample, 15% of sarcopenic subjects were malnourished. On the other hand, FNIH criteria led us to opposite findings, since no sarcopenic subject was malnourished, but 7.7% of them were obese. This significant gap can be justified by the different method used to assess low muscle mass by the two definitions of sarcopenia: EWGSOP suggests to standardize ALM by meters squared while FNIH suggests to standardize ALM by Body Mass Index. As reported by Dam et al. [6] sarcopenic subjects identified by

Table II. Univariate and multivariate logistic regression analyses for the likelihood of being sarcopenic according to sarcopenia definition.

	EWGSOP				FNIH			
	Univariate		Multivariate		Univariate		Multivariate	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Sex (male)	3.99 (1.20-23.31)	0.024	12.1 (2.3-63-7)	0.003	5.9 (1.71-20.13)	0.005	5.52 (1.54-19.9)	0.009
Age (years)	0.99 (0.93-1.05)	0.631			1.02 (0.95-1.09)	0.593		
Education (≥ 5 years)	1.58 (0.40-6.21)	0.513			0.47 (0.14-1.53)	0.209		
Smokers	1.91 (0.58-6.25)	0.283			1.91 (0.58-6.25)	0.283		
BMI (kg/m^2)	0.72 (0.60-0.88)	0.001	0.64 (0.50-0.82)	< 0.001	1.03 (0.91-1.16)	0.689		
Weight loss (last 6 months)	1.50 (0.37-6.16)	0.574			1.50 (0.37-6.16)	0.574		
Severe Functional Disability (%)	1.25 (0.35-4.48)	0.729			2.74 (0.83-9.11)	0.099		
Severe Mobility Impairment (%)	0.76 (0.22-2.67)	0.669			1.13 (0.34-3.75)	0.848		
CIRS severity	1.79 (0.43-7.48)	0.421			1.71 (0.41-7.08)	0.458		
CIRS comorbidity	1.31 (0.93-1.85)	0.127			1.54 (1.07-2.21)	0.019	1.48 (1.02-2.16)	0.039
Cognitive impairment (n = 95, %)	0.92 (0.27-3.16)	0.900			2.48 (0.64-9.69)	0.191		
Number of medications	0.92 (0.75-1.14)	0.461			0.91 (0.73-1.14)	0.408		

OR = odds ratio; CI = confidence interval; BMI = body mass index; CIRS = cumulative illness rating scale.

EWGSOP criteria have lower obesity prevalence compared to those identified with FNIH criteria; furthermore the FNIH criteria identified participants that, despite having higher lean mass and higher BMI, are functionally more impaired. These data suggest that the use of lean mass adjusted by body mass seems to be the best choice to capture subjects that are unable to generate enough muscular strength or to achieve an adequate physical performance relative to their body mass and that ALM/BMI may be a good measure for low muscle quality or efficiency [6 17].

These results suggest that the EGWOSP and FNIH criteria identify as sarcopenic different individuals and therefore the two definitions cannot be used interchangeably. Since more than one out of five subjects of this study were found to be obese, we can assume that the results obtained according to FNIH sarcopenia definition may offer a better representation of the actual sarcopenia prevalence in this population. Furthermore, FNIH definition seems to identify a sarcopenia phenotype with higher comorbidity level and functional disability. Nevertheless, longitudinal studies should be performed to directly compare the predictive value in term of clinical outcomes of the two diagnostic algorithm.

In interpreting our findings, some limitations should be considered. First, the setting limited generalization of our findings: the high prevalence of functional impairment along the low cooperation offered from subjects with cognitive impairment may have partially compromised the usefulness of the result obtained from the gait speed and grip strength tests, as stated before in literature with similar population [7]. Second, of the 158 residents, only 97 were included in this study; the majority of the excluded residents presented health-related conditions: healthy selection bias has to be taken into account and therefore our analyses might have underestimated the true prevalence of sarcopenia. Third, the cross-sectional design of the study did not allow us to clarify any temporal or cause-effect relationship between sarcopenia and its associated factors. Fourth, the low number of subject defined as sarcopenic (13 according to both definitions) might have limited the statistical significance of the multivariate analyses. Finally, the use of BIA for muscle mass assessment presents some drawbacks mainly due to the hydration problems usually observed in older persons, that may result in an underestimation of the body fat and an overestimation of fat-free mass. On the other hand, BIA is inexpensive, easy to use, readily reproducible, and appropriate for both ambulatory and bedridden patients, considered as a portable alternative to dual-energy X-ray absorptiometry [9], and its standardized use may favor a widespread assessment of body composition in everyday clinical practice and in nursing home residency.

In summary, in this sample of Italian institutionalized older people, both EWGSOP and FNIH criteria identify

sarcopenia as a common condition, strongly related to male sex, BMI and comorbidity level. Our results suggest that the EGWOSP and FNIH criteria cannot be used interchangeably, since both definition identified as sarcopenic different individuals. Finally, this study reinforce the notion that walking speed assessment might not be feasible in most of the patients admitted in nursing home facilities.

Conflict of interest

The authors declare no conflict of interest.

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