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Prevalence and Risk Factors of Sarcopenia Among Nursing Home Older Residents

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BACKGROUND AND AIM. Sarcopenia has been indicated as a reliable marker of frailty and poor prognosis among the oldest individuals. At present, there are no data on sarcopenia in nursing home population. We evaluated the prevalence of sarcopenia and its association with functional and clinical status in a population of elderly persons aged 70 years and older living in nursing homes.

METHODS. This study was conducted selecting all the participants (n = 122) living in the teaching nursing homes of Catholic University of Rome who were aged 70 years and older from August 1, 2010, to September 30, 2010. The European Working Group on Sarcopenia in Older People (EWGSOP) criteria were adopted. Accordingly, diagnosis of sarcopenia required the documentation of low muscle mass plus the documentation of either low muscle strength or low physical performance.

RESULTS. Forty residents (32.8%) were identified as affected by sarcopenia. The multivariate logistic regression analysis showed a high increase in risk of sarcopenia for male residents (odds ratio [OR] 13.39; 95% confidence interval [CI] 3.51–50.63) and for residents affected by cerebrovascular disease (OR 5.16; 95% CI 1.03–25.87) or osteoarthritis (OR 7.24; 95% CI 2.02–25.95). Residents who had a body mass index higher than 21 kg/m² had a lower risk to be sarcopenic (OR 0.76; 95% CI 0.64–0.90) relative to those with body mass index less than 21 kg/m². Similarly, sarcopenia was less likely to be present among participants involved in leisure physical activity for 1 hour or more per day (OR 0.40; 95% CI 0.12–0.98).

CONCLUSIONS. The present study suggests that among participants living in nursing homes, sarcopenia is highly prevalent and it is more represented among male residents (68%) than among female residents (21%). Our findings support the hypothesis that muscle mass is strongly associated with nutritional status and physical activity in nursing homes, too.

KEY WORDS: — Sarcopenia—Nursing home—Frail elderly.

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SINCE 1989, when Irwin Rosenberg proposed the term sarcopenia (Greek “sark” = flesh + “penia” = loss) to describe the age-related decrease of muscle mass (1), there has been an exponential increase in the number of publications defining sarcopenia and its relation with functional loss, disability, survival, and the burden for the health care system (2). In the past 20 years, many authors have investigated the histological changes of the muscle during the aging process, showing a progressive reduction of the number and the size of muscle fibers (in particular type II fibers) starting from the third decade of life (2).

Based on common clinical experience, a high prevalence and incidence of sarcopenia among older participants living in nursing homes may be expected. However, we searched MEDLINE and the Cochrane Central Register of Controlled Trials for published articles on “sarcopenia” in “nursing home” residents using the “sensitive search method” and found limited evidence on this topic. We also gathered sparse data on sarcopenia in nursing homes after looking for abstracts presented at major international scientific meetings (Gerontological Society of America, American Geriatric Society, American Medical Directors Association annual meetings).

At present, there are no data from representative large samples on the epidemiology of sarcopenia in nursing home residents. In a recent review article, Bauer and colleagues (3) addresses the importance of definition and pathophysio-
ology of sarcopenia, the practical approaches toward a diagnosis of sarcopenia in nursing home residents, and the treatment options. As indicated in this review, some data are available from observational studies assessing the nutritional status in nursing home residents. Anthropometric parameters have been used to evaluate the muscle mass. In a first study examining 115 nursing home residents in the United States, low arm–muscle circumference was documented in 85% of study sample (4). Data from Saudi nursing homes showed a low mid-arm circumference in 40% of residents (5). More recently, Bahat and colleagues (6) have investigated the prevalence of sarcopenia in nursing homes using the bioelectrical impedance analysis. In this study, the prevalence of sarcopenia among institutionalized male elderly individuals in Turkey was about 85%.

Such high variability of frequency estimates can be in some extent attributed to the different characteristics of the study samples and to the different methods used to assess sarcopenia. Despite a growing interest of scientific community to such condition, information on sarcopenia in nursing homes and its relation to physical function is still lacking.

We conducted an observational cross-sectional study to evaluate the prevalence of sarcopenia and its association with clinical and functional domains in a large population of frail and old participants residing in the teaching nursing homes of Catholic University of Rome (Santa Maria della Pace, Fontecchio-Celano).

METHODS

This study was conducted in the teaching nursing homes of Catholic University, which are located in Central Italy (Fontecchio-Celano, Abruzzo Region). Informed consent was elaborated and administered using methods approved by the Catholic University of Sacred Heart of Rome. The Opera Santa Maria della Pace Ethical Committee ratified the entire study protocol.

Study Population

For the present study, we selected all those participants \( n = 146 \) residing in the teaching nursing homes of Catholic University of Rome (Opera Santa Maria della Pace) during the time period between August 1, 2010, and September 30, 2010, who were aged 70 years and older. Twenty-four participants \( (16\%) \) were considered not eligible for the study due to comatose status \( (n = 4) \), hemiplegia \( (n = 7) \), paraplegia \( (n = 3) \), or because bedridden for terminal illness \( (n = 10) \). This selection resulted in a final sample of 122 participants.

Data Collection

All the participants enrolled in the present study were evaluated using the Minimum Data Set assessment form for the Nursing Home (MDS-NH) \((7,8)\). The MDS-NH is a comprehensive, validated, and standardized instrument for evaluating the needs, strengths, and preferences of elderly individuals admitted to a nursing home \((9)\).

The Minimum Data Set for Nursing Home form was administered to all study participants following the guidelines published in the MDS-NH manual \((7)\). The MDS-NH contains over 350 data elements including sociodemographics, physical, and cognitive status variables, as well as major clinical diagnoses \((7,9)\). Moreover, the MDS-NH allows to collect information about an extensive array of signs, symptoms, syndromes, and treatments. The MDS-NH items have shown an excellent interrater and test–retest reliability when completed by nurses performing usual assessment duties \((average \ weighted \ kappa = 0.8)\) \((8,10)\). Assessors were trained on how to perform each component of the MDS-NH assessment form.

Functional and Cognitive Status Measures

Basic activities of daily living \( (ADL) \) were assessed using the MDS-NH instrument. The ADL scale is based on seven levels of self-performance, including dressing, eating, toilet use, bathing, mobility in bed, locomotion, and transfer. Cognitive performance was assessed using a six-item seven-category scale \( (Cognitive \ Performance \ Scale) \) \((10)\). The Cognitive Performance Scale was scored on a 7-point ordinal scale in which higher scores were associated with worse cognitive performance. The Cognitive Performance Scale considers two cognitive items \( (short-term \ memory, \ skills \ for \ daily \ decision \ making) \), one item describing communication ability \( (understood \ by \ others) \), one ADL measure \( (self-performance \ in \ eating) \), and whether in comatose status.

Covariates

Medical diagnoses were defined as conditions that have a relationship with patients’ functional, cognitive, and behavioral status; medical treatment; and risk of death. The diagnoses were listed on the MDS-NH form in a check-box section containing 27 specific diagnostic categories. Drugs were coded using the Anatomical Therapeutic and Chemical codes.

Body weight was measured while wearing light clothes using a calibrated bathroom scale. Body height was measured using a standard stadiometer. Body weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively.

Body mass index \( (BMI) \) was defined as weight \( (\text{kilograms}) \) divided by the square of height \( (\text{meters}) \).

Assessment of Sarcopenia

Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with an impaired physical performance \((2,11)\). For the present study, we adopted the European Working Group on
Sarcopenia in Older People (EWGSOP) criteria (12). The EWGSOP recommends using the presence of both low muscle function (strength or performance) and low muscle mass for the diagnosis of sarcopenia. Thus, diagnosis of sarcopenia in the present study sample required the documentation of low muscle mass plus the documentation of either low muscle strength or low physical performance.

**Physical Performance Assessment—Four-Meter Walking Test**

Walking speed was evaluated measuring participants’ usual gait speed (in meters per second) over a 4-m course. A cutoff point of more than 0.8 m/s identifies participants with low physical performance (12). This cutoff point was similar to that obtained among 469 men and 561 women (age range from 20 to 102 years) from the InCHIANTI study population (13).

**Muscle Strength Measure—Hand Grip**

Muscle strength was assessed by hand grip strength, which was measured using a dynamometer (North Coast Hydraulic Hand Dynamometer; North Coast Medical Inc, Morgan Hill, CA). One trial for each hand was performed, and the result from the strongest hand was used for the present analyses.

Using the cutoff points indicated in the EWGSOP consensus paper (12), low muscle strength was classified as hand grip less than 30 and 20 kg in men and women, respectively. These cut-points were similar to that obtained among 469 men and 561 women (age range from 20 to 102 years) from the InCHIANTI study population (13).

**Muscle Mass Assessment—Bioelectrical Impedance Analysis**

The muscle mass was measured by bioelectrical impedance analysis (BIA). Bioelectrical impedance analysis resistance (ohms, Ω) was obtained using a Quantum/S Bioelectrical Body Composition Analyzer (Akern Srl, Florence, Italy) with an operating frequency of 50 kHz at 800 μA. Whole-body bioelectrical impedance analysis measurements were taken between the right wrist and ankle with the subject in a supine position (14). Muscle mass was calculated using the bioelectrical impedance analysis equation of Janssen and colleagues (15):

\[
skeletal \text{ muscle mass} (\text{kg}) = \left[ \frac{\text{height}^2}{\text{BIA resistance} \times 0.401} \right] + (\text{gender} \times 3.825) + (\text{age} \times -0.071) + 5.102,
\]

where height is measured in centimeters; bioelectrical impedance analysis resistance is measured in ohms; for gender, men = 1 and women = 0; and age is measured in years.

Absolute skeletal muscle mass was converted to skeletal muscle index by dividing height by meters squared (kg/m^2) (16). Low muscle mass was defined as the skeletal muscle index of 2 SDs or more below the normal sex-specific means for young persons (16,17). Using the cutoff points indicated in the EWGSOP consensus paper (12), low muscle mass was classified as the skeletal muscle index less than 8.87 and 6.42 kg/m^2 in men and women, respectively. These cutoff points were similar to those obtained among 2,276 elderly (≥ 60 years) women and 2,223 elderly men from the Third National Health and Nutrition Examination Survey (NHANES III) (18).

![Figure 1](https://academic.oup.com/biomedgerontology/article-abstract/67A/1/48/583815)

Figure 1. Study profile using the European Working Group on Sarcopenia in Older People—suggested algorithm for sarcopenia case finding in older individuals. SMI = skeletal muscle index obtained by absolute skeletal muscle mass divided by height by meters squared (kg/m^2).
PREVALENCE AND RISK FACTORS OF SARCOPENIA

Statistical Analysis

Residents with sarcopenia were identified using the algorithm developed and suggested by the EWGSOP (12) for sarcopenia case finding and screening in practice (Figure 1).

Data were analyzed to obtain descriptive statistics. Continuous variables are presented as mean and standard deviation. Differences in sociodemographic, functional, and clinical characteristics between residents with sarcopenia and residents without sarcopenia were analyzed in different ways. Quantitative parameters with normal distribution were tested by one-way analysis of variance, after a pretest for homogeneity of variances. If abnormal distribution was present, a nonparametric test was used (Kruskal–Wallis rank test). Categorical variables were analyzed by the χ² test. A p < .01 level was chosen for statistical significance.

The relationship between sarcopenia and clinical and functional variables was estimated by deriving odds ratios (ORs) from multiple logistic regression models. Sarcopenia identified by the EWGSOP algorithm was included as a dependent variable in such models. Based on previous researches, we considered age, gender, length of stay in facility, functional ability (ADL score), cognitive performance (Cognitive Performance Scale score), diagnosis of dementia, Parkinson’s disease, cerebrovascular disease, chronic obstructive pulmonary disease, cancer, osteoarthritis, physical activity, and BMI as factors potentially associated with sarcopenia and included them as independent variables in the models.

We provided estimates of association while adjusting for potential confounders by deriving crude and adjusted ORs and the corresponding 95% confidence intervals (CIs) from these models.

All analyses were performed using the SPSS 10.0 package (SPSS Inc., Chicago, IL).

RESULTS

Mean age of study participants was 84.1 (standard deviation 4.8) years, and 91 residents (75.0%) were women. Using the EWGSOP-suggested algorithm for sarcopenia case finding in older individuals (12), 40 residents (32.8%) were identified as affected by sarcopenia (Figure 1). Residents with sarcopenia showed a statistically significant lower skeletal muscle index compared with participants without sarcopenia (6.3 vs 11.7 kg/m², p < .001, respectively). Similarly, compared with nonsarcopenic residents, they were significantly slower in the 4-m walking test (0.06 vs 0.17 m/s, p < .01, respectively). No difference was observed at the hand grip test. Male residents were more likely to be affected by sarcopenia than female residents (67.7% vs 20.8%, p < .001, respectively).

The sociodemographic, functional, cognitive, and clinical characteristics and drug use of study participants according to the presence of sarcopenia are summarized in Table 1. Compared with residents without sarcopenia, those diagnosed with sarcopenia were more likely to be functionally impaired (ADL scale score 5.0 vs 3.9, p = .02, respectively) and showed lower BMI (mean BMI 20.4 vs 22.3 kg/m², p = .03, respectively). Also, relative to nonsarcopenic residents, those with sarcopenia were less likely to be involved in leisure physically activities (50.0% vs 7.8%, p < .03, respectively). Overall, the mean number of diseases was similar

Table 1. Characteristics of Study Participants According to the Presence of Sarcopenia

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Sample (n = 122)</th>
<th>Sarcopenia (n = 40)</th>
<th>No Sarcopenia (n = 82)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>84.1 ± 6.9</td>
<td>84.6 ± 7.3</td>
<td>83.1 ± 6.0</td>
<td>.3</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>91 (75)</td>
<td>19 (21)</td>
<td>72 (79)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31 (25)</td>
<td>21 (68)</td>
<td>10 (32)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>22 (20)</td>
<td>7 (18)</td>
<td>15 (19)</td>
<td>.4</td>
</tr>
<tr>
<td>Widowed</td>
<td>72 (60)</td>
<td>23 (57)</td>
<td>49 (60)</td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>28 (20)</td>
<td>11 (25)</td>
<td>17 (21)</td>
<td></td>
</tr>
<tr>
<td>Length of stay in facility, mo</td>
<td>24.7 ± 26.2</td>
<td>19.9 ± 21.8</td>
<td>27.0 ± 27.9</td>
<td>.1</td>
</tr>
<tr>
<td>Activity of daily living score</td>
<td>4.2 ± 2.4</td>
<td>5.0 ± 2.2</td>
<td>3.9 ± 2.5</td>
<td>.02</td>
</tr>
<tr>
<td>Cognitive Performance Scale score</td>
<td>3.9 ± 1.9</td>
<td>3.9 ± 2.1</td>
<td>3.9 ± 1.9</td>
<td>.8</td>
</tr>
<tr>
<td>Number of diseases</td>
<td>3.2 ± 1.3</td>
<td>3.4 ± 1.1</td>
<td>3.2 ± 1.3</td>
<td>.5</td>
</tr>
<tr>
<td>Specific diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dementia</td>
<td>74 (61)</td>
<td>19 (47)</td>
<td>55 (67)</td>
<td>.03</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>12 (10)</td>
<td>6 (15)</td>
<td>6 (7)</td>
<td>.1</td>
</tr>
<tr>
<td>Cerebrovascular diseases</td>
<td>29 (24)</td>
<td>14 (35)</td>
<td>15 (18)</td>
<td>.03</td>
</tr>
<tr>
<td>Hypertension</td>
<td>76 (62)</td>
<td>22 (55)</td>
<td>54 (66)</td>
<td>.1</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>15 (12)</td>
<td>6 (15)</td>
<td>9 (11)</td>
<td>.4</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>20 (16)</td>
<td>4 (10)</td>
<td>16 (20)</td>
<td>.1</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>13 (11)</td>
<td>7 (18)</td>
<td>6 (7)</td>
<td>.05</td>
</tr>
<tr>
<td>Depression</td>
<td>21 (17)</td>
<td>10 (25)</td>
<td>11 (13)</td>
<td>.09</td>
</tr>
<tr>
<td>Cancer</td>
<td>5 (4)</td>
<td>3 (7)</td>
<td>2 (2)</td>
<td>.1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>20 (16)</td>
<td>7 (18)</td>
<td>13 (16)</td>
<td>.5</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>55 (45)</td>
<td>23 (57)</td>
<td>32 (39)</td>
<td>.04</td>
</tr>
<tr>
<td>Number of medications</td>
<td>5.4 ± 2.1</td>
<td>5.3 ± 1.9</td>
<td>5.4 ± 2.2</td>
<td>.8</td>
</tr>
<tr>
<td>Leisure physical activity (last 3 d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never or less than 1 h/d</td>
<td>38 (31)</td>
<td>20 (50)</td>
<td>18 (22)</td>
<td>.002</td>
</tr>
<tr>
<td>1 h or more per day</td>
<td>84 (69)</td>
<td>20 (50)</td>
<td>64 (78)</td>
<td></td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>21.7 ± 4.5</td>
<td>20.4 ± 4.0</td>
<td>22.3 ± 4.7</td>
<td>.03</td>
</tr>
<tr>
<td>Four-meter walking test, m/s</td>
<td>0.14 ± 0.20</td>
<td>0.06 ± 0.15</td>
<td>0.17 ± 0.21</td>
<td>.005</td>
</tr>
<tr>
<td>Hand grip strength, kg</td>
<td>8.2 ± 6.8</td>
<td>8.2 ± 6.3</td>
<td>8.3 ± 7.6</td>
<td>.9</td>
</tr>
<tr>
<td>Skeletal muscle index, kg/m²</td>
<td>9.9 ± 3.8</td>
<td>6.3 ± 1.4</td>
<td>11.7 ± 3.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hematological parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin, g/dl</td>
<td>3.12 ± 0.52</td>
<td>3.03 ± 0.49</td>
<td>3.20 ± 0.53</td>
<td>.6</td>
</tr>
<tr>
<td>Hemoglobin, g/dl</td>
<td>12.2 ± 1.6</td>
<td>12.1 ± 1.7</td>
<td>12.2 ± 1.6</td>
<td>.8</td>
</tr>
</tbody>
</table>

Notes: Data are given as number (percentage) for the following variables: gender, marital status, specific diseases, physical activity; for all the other variables means ± SD are reported. Differences in proportions and means of covariates were assessed using Fisher exact test and analysis of variance test statistics, respectively. Activity of Daily Living Scale ranges from 0 (no functional impairment) to 7 (severe functional impairment). Cognitive Performance Scale ranges from 0 (no cognitive impairment) to 6 (severe cognitive impairment).
between sarcopenic and nonsarcopenic residents. However, Parkinson’s disease, cerebrovascular diseases, chronic obstructive pulmonary disease, and osteoarthritis were more common among residents with sarcopenia relative to nonsarcopenic participants. Diagnosis of dementia of any type was more frequent among residents without sarcopenia relative to those with such condition.

Results from univariate and multivariate logistic regression models are reported in Table 2. After adjusting for potential confounders, an increased risk of sarcopenia was found in male residents (OR 13.39; 95% CI 3.51–50.63) and in those residents affected by cerebrovascular disease (OR 2.68; 95% CI 0.83–8.60) or osteoarthritis (OR 2.40; 95% CI 1.02–5.67). Sarcopenia was inversely associated with BMI with those residents with BMI higher than 21 kg/m² showing a lower risk of sarcopenia relative to those with BMI less than 21 kg/m² (OR 0.76; 95% CI 0.64–0.90). Similarly, sarcopenia was less likely to be present among residents involved in leisure physical activities for 1 hour or more per day (OR 0.40; 95% CI 0.12–0.98).

**Table 2. Unadjusted and Adjusted Model for Risk of Sarcopenia in the Study Population**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Univariate Odds Ratio (95% CI)</th>
<th>p</th>
<th>Adjusted Model* Odds Ratio (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70–80</td>
<td>1.0 (referent)</td>
<td></td>
<td>1.0 (referent)</td>
<td></td>
</tr>
<tr>
<td>≥80</td>
<td>0.97 (0.92–1.02)</td>
<td>.31</td>
<td>0.96 (0.88–1.04)</td>
<td>.33</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.0 (referent)</td>
<td></td>
<td>1.0 (referent)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7.95 (3.21–19.71)</td>
<td>&lt;.001</td>
<td>13.39 (3.51–50.63)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Length of stay in facility</td>
<td>0.98 (0.97–1.00)</td>
<td>.93</td>
<td>0.99 (0.97–1.01)</td>
<td>.49</td>
</tr>
<tr>
<td>Compromised ADL function†</td>
<td>1.20 (1.01–1.42)</td>
<td>.03</td>
<td>1.15 (0.87–1.51)</td>
<td>.31</td>
</tr>
<tr>
<td>Impaired cognitive performance‡</td>
<td>0.98 (0.81–1.19)</td>
<td>.87</td>
<td>0.97 (0.63–1.51)</td>
<td>.91</td>
</tr>
</tbody>
</table>

**Notes:**
*Adjusted simultaneously for all the variables listed.
†Activities of daily living (ADL) score is at least 2 (range 0–7, a higher number indicates higher impairment).
‡Cognitive Performance Scale scores equal 2 or more (range 0–6, a higher number indicates higher impairment).

**Discussion**

In the present study, we estimated the prevalence of sarcopenia and the association of such condition with functional and clinical status in a population of elderly persons aged 70 years and older living in nursing homes. Our findings show that sarcopenia—assessed using the EWGSOP algorithm (12)—is highly prevalent in institutionalized elderly persons (68% among male residents and 21% among female residents). After adjustment for potential confounders, only specific diseases (cerebrovascular diseases, Parkinson, and osteoarthritis) were directly associated with the presence of sarcopenia. Furthermore, in the present study, a good nutritional status and the involvement in daily leisure physical activities were inversely associated with the presence of sarcopenia. Participants with the BMI more than 21 kg/m² and those involved in leisure physical activity for 1 hour or more per day showed the lowest risk to be sarcopenic, regardless of age, gender, and other confounding factors.

**Prevalence of Sarcopenia in Nursing Home Residents**

Aging is associated with significant changes in body composition, with a substantial reduction in fat-free mass and muscle mass and an increase in visceral fat (2). As expected, sarcopenia is highly prevalent among the population over the age of 65 years and more. However, the prevalence of sarcopenia varies across diverse populations and according to age, gender, and living setting (3). Based on findings from previous studies, the prevalence of sarcopenia ranges between 5% and 13% among 60- to 70-year-old individuals and between 11% and 50% in those aged 80 years or older (19), depending on the adopted definition for such condition.

Estimates of frequency of sarcopenia in nursing homes derive from studies conducted on small samples of residents and which adopted different measurement techniques (4–6). At present, there are no data from large multicenter and/or multinational studies on the prevalence and correlates of sarcopenia in nursing homes. Furthermore, no research article that relies on the accepted sarcopenia criteria in nursing home residents has been published (14,16). The present study is the first attempt to estimate the prevalence of sarcopenia in nursing homes using the suggested EWGSOP-screening algorithm (12).

In this respect, it is important to highlight that an operational definition of sarcopenia needs to be adopted and included in the mainstream of comprehensive geriatric assessment. Because the consequences of sarcopenia in older people are serious and life-changing, health care professionals are challenged to work together to turn our growing body of knowledge into actions that will improve the health and well-being of older people living in nursing homes.

**Diagnosis of Sarcopenia in Nursing Home Residents**

Despite the increased knowledge and improved technology to assess sarcopenia, a worldwide operational definition applicable across age/gender groups and populations lacks consensus. Recently, the EWGSOP has developed an
algorithm based on gait speed measurement as the easiest and most reliable way to begin sarcopenia case finding or screening in practice, using the cutoff point of more than 0.8 m/s for sarcopenia (20). According to the EWGSOP consensus definition (12), sarcopenia can be diagnosed when both low muscle mass and low muscle function (strength or performance) are present. This definition and the suggested algorithm are useful to screen and diagnose this condition in nursing home residents. However, the feasibility of such approach may be limited.

First, the gait speed and the hand grip measurements could be limited by functional impairment, which is frequent in nursing home residents. For both these two measurements, it is essential that the participant is able to cooperate. In residents with multimorbidity, functional and cognitive impairment, or depression, it may be difficult to obtain clinically useful results. It is noteworthy that in our study sample, only three participants (2.5%) were able to perform the 4-m walking test in less than 0.8 m/s. As a consequence, in such functionally compromised participants, muscle mass measurements may be more valuable than function measurements.

The dual energy X-ray absorptiometry (DEXA) and the bioelectrical impedance analysis (BIA) are common methods to assess the skeletal muscle mass (21). DEXA is an attractive method both for research and for clinical use to distinguish lean tissues, fat, and bone mineral. The main disadvantage of such technique is that the DEXA equipment is not portable, which may exclude its use in large-scale epidemiological studies and may limit its use in older adults with functional limitations living at home or in institutional frailty (17). The bioimpedance analysis might be a good portable alternative to DEXA, estimating the volume of fat and lean body mass. The BIA test itself is inexpensive, easy to use, readily reproducible, and appropriate for both ambulatory and bedridden patients. The BIA measurement techniques, used under standard conditions, have been found to correlate well with magnetic resonance imaging measures (14,22). The BIA equation was developed and has been cross-validated for multiethnic adults (14) and reference values established for adult white men and women, including older participants (23). It is important to highlight that an increased amount of total body water and in particular of extracellular water may result in an underestimation of the body fat and an overestimation of fat-free mass. For this reason, the hydration problems usually observed over aging need to be considered as a limitation in the use of BIA in such population.

Nevertheless, these technologies (DEXA and BIA) may not be available and their use among elderly patients living in nursing home may be limited. Recently, anthropometric measurements are assuming growing importance for the sarcopenia assessment in frail elderly people (3). Mid-arm muscle circumference has been shown a useful indicator of nutritional status and muscle mass in older adults in addition to other anthropometric techniques such as height and weight (11,24). Mid-arm muscle circumference can be estimated using a standard formula that takes into account the mid-upper arm circumference and the triceps skinfold thickness of the right arm. Measurements of arm muscle circumference may be useful as quick and low-cost screening test for the diagnosis of sarcopenia in nursing homes when DEXA or BIA is not available.

**Treatment Options for Sarcopenia in Nursing Home Residents**

The relationship between muscle mass, strength, physical function, and nutritional status have significant clinical implications regarding the therapeutic approaches (25–27). It is important to highlight that in our sample, malnutrition (BMI <21 kg/m²) and inactivity (never or <1 hour involvement in leisure physical activity) were associated with an increased risk of sarcopenia. In this respect, the most important treatment option in nursing home residents includes physical activity programs and nutritional intervention.

A sedentary lifestyle has been shown to be a risk factor for muscle weakness that, in turn, results in reduced activity levels, loss of muscle mass, and muscle strength (28). Many studies have hypothesized that specific programs of physical activity represent the most important approach to slow down the decline of muscle mass and muscle strength associated with aging and the maintenance of physical activity were associated with an increased risk of sarcopenia. In this respect, the most important treatment option in nursing home residents includes physical activity programs and nutritional intervention.

Recommendations for older people include a balance program of both endurance and strength exercises, performed on a regular schedule (at least 3 d/wk). However, such recommendations should be tailored on the institutionalized frail elderly with preexisting medical conditions and special needs. While a nursing home activity planning is a universal need, a revised activity care plan may be required to identify those residents whose inactivity may be a major complication in their lives. Moderate physical activity carried out as part of everyday activities can be of substantial benefit even to frail and older persons living in nursing home. Vigorous exercise is not always required, while regular leisure activities—such as walking, gardening, or dancing—seem to be enough to reach considerable benefits (31). Fiatarone and colleagues (32) specifically demonstrated the positive impact of resistance training and nutritional supplementation in elderly nursing home residents (33).
Adequate caloric intake has to be considered as an essential requisite for any successful therapeutic approach in the institutionalized elderly participants, in terms of prevention and treatment of sarcopenia. Many studies underlined the importance of nutrition screening and assessment in the long-term setting (34,35). In particular, the nutritional assessment should be part of the comprehensive geriatric assessment in nursing homes in order to identify those residents with malnutrition and those who are at risk of developing such condition. Assessment also provides the information needed for intervention, planning, and improvement of nutritional care. Nutritional interventions address the multifactorial causes of nutritional problems and include nutrition education, nutrition counseling, specialized medical and dietary treatments, and oral nutrition supplementation. Nutritional interventions in nursing homes aim at providing the resident with sufficient nutrition with respect to amounts of energy, protein, and micronutrients.

Elderly participants living in nursing homes may have higher protein requirements than those indicated in clinical recommendations. The daily protein intake for sarcopenic residents may be appropriate at levels between 1 and 1.2 g/kg of body weight (36). Muscle protein synthesis is directly stimulated by amino acids intake, and protein supplementation has been investigated in the prevention of sarcopenia (37). Recently, some studies have documented that the supplementation of high concentrations of essential amino acids exerts a positive effect on muscle protein synthesis and leads to an increase in fat-free mass and in muscle strength in the elderly participants (38).

Several epidemiological studies have documented the association between low levels of vitamin D and low muscle mass and strength (39). Taking into account the high prevalence of vitamin D deficiency (>70%) among institutionalized participants, vitamin D supplementation has to be considered as a possible approach to prevent sarcopenia and to improve the effects of sarcopenia in terms of morbidity and mortality in this population. Vitamin D plasmatic levels should be measured in institutionalized individuals. Vitamin D oral supplementation should be provided to residents with vitamin D plasmatic levels lower than 30 ng/ml (40).

At the present, there are no data supporting the use of other treatment options hypothesized to be useful for sarcopenia—testosterone, growth hormones, angiotensin-converting-enzyme-inhibitors—in nursing homes (40).

**Conclusions**

Some methodological issues may have influenced our results. As in all cohort studies, selective survival before entry the cohort has to be taken into account. The cross-sectional design of the study does not allow to clarify any cause-effect relationships. Furthermore, in this observational study, results may be confounded by unmeasured factors. Taking into account these limitations, the present study suggests that sarcopenia is highly prevalent among participants living in nursing homes especially among male residents. Our findings support the hypothesis that muscle mass is strongly associated with nutritional status and physical activity. At this time, data are accumulating on the mechanisms of sarcopenia, and tools for the screening and assessment of such condition are increasingly used in nursing homes. Further research is needed to establish the role of sarcopenia on determining clinical outcomes among nursing home residents and to provide evidence for nutrition and physical interventions aimed at preventing sarcopenia.

**Conflict of Interest**

None.

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