Case Report

Severe osteopenia and osteoporosis, sarcopenia, and frailty status in community-dwelling older women: Results from the Women's Health and Aging Study (WHAS) II

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A B S T R A C T

Objectives: The goal of this study was to examine the associations between severe osteopenia and osteoporosis and/or sarcopenia on frailty status, a major geriatric syndrome in community-dwelling older women.

Design: Cross-sectional analysis.

Setting: Women’s Health and Aging Studies II (WHAS-II), Baltimore, Maryland.

Participants and measurements: The analytic sample for this study included 250 women aged 76–86 years old who underwent DXA evaluation at round 4. Frailty was determined using validated screening criteria. Severe osteopenia was defined as BMD between −2.0 SD and −2.49 SD and osteoporosis as BMD less than −2.5 SD (lumbar spine and/or proximal femur). Sarcopenia was determined by the appendicular lean mass by height² (aLM/ht² method) and considered present when the value was less than −2 SD compared to young women.

Results: Mean age of study subjects was 79.6 (±2.7) years. Overall prevalence of frailty was 6.8% (n = 17). Severe osteopenia/osteoporosis occurred in 42.1% (n = 7) in the frail group, 28% (n = 33) in the pre-frail group and 25.2% in the robust group. Sarcopenia was present in 52.9% (n = 9) in the frail group, 42% (n = 50) in the pre frail and 41.2% (n = 47) in the robust group. Almost sixteen percent (n = 39) had severe osteopenia/osteoporosis concomitant to sarcopenia. In an adjusted logistic regression model, severe osteopenia/osteoporosis (OR: 2.1; 95% CI: 1.1–3.9) and sarcopenia (OR: 3.1; 95% CI: 0.88–11.1; p = 0.077) were individually associated with frailty, though not statistically significant. On the other hand, the likelihood of being frail was substantially higher in the presence of these two syndromes (OR: 6.4; 95% CI: 1.1–36.8, p = 0.037).

Conclusion: These findings suggest a concomitant impact of severe osteopenia/osteoporosis plus sarcopenia in regard to frailty status in a sample of oldest old women living in the community.

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Introduction

Frailty is a major geriatric syndrome characterized by low muscle strength [1,2], decreased walking speed [3], weight loss [4], low physical activity [5], and falls and fractures [6]. It commonly occurs in older adults, and results in an increased risk of adverse health outcomes including decreased quality of life, disability, recurrent hospitalizations, and death [7–9]. Consistently, studies have discussed a theoretical link between sarcopenia, an age related decrease in muscle strength and mass, and the complex pathogenesis of frailty and its major outcomes [4,6,7,10]; however, the literature has not been able to establish if this association is only with muscle strength and/or muscle mass. Older women with decreased muscle mass are three times more likely to develop functional impairment [11] and disability [12] and, in the United States, sarcopenia related healthcare expenses have been estimated at $18.5 billion in 2000 ($10.8 billion in men, $7.7 billion in women) [13].

Osteoporosis has also been associated with frailty status in elderly women, but this has not been clearly demonstrated [6,14–18]. In the Study of Osteoporosis Fractures (SOF) [14], a prospective cohort study, frail elderly women had lower bone mineral density (BMD) and a 1.7- to 1.8-fold increased risk of hip fracture and a 1.5-fold increased risk of any non-spinal fracture compared to robust women, but the association between osteoporosis and frailty patients with fractures or low BMD was not shown.
The association between sarcopenia and osteoporosis with frailty may be the result of common etiologic factors like mechanical factors [19], vitamin D deficiency [20], low levels of testosterone [21], estrogens, sulfate of dihydroepiandrostenedione (S-DHEA) [22] and insulin growth factor I (IGF-I) [23], inflammation (high levels of IL-6 and TNF α) [23,24], decreased food intake and malnutrition [25].

The goal of this study was to assess the individual and the joint impact of severe osteopenia/osteoporosis and sarcopenia on the frailty status in community older women using dual energy X-ray absorptiometry (DXA) derived measurements. We hypothesized that the frailty likelihood would be highest in the presence of both sarcopenia and severe osteopenia and osteoporosis, lowest when none of these impairments were prevalent, and intermediate in the presence of one of the two impairments.

Methods

Population

Women Health and Aging—observational Study II (WHAS II) is a population-based study designed to evaluate the causes and course of physical disability in community-dwelling older women. The WHAS II cohort was recruited from a high functioning age-stratified random sample of women aged 70–79 years old from Medicare enrollees residing in 12 contiguous ZIP code areas in Baltimore, Maryland [26].

Eligibility criteria for screening for the WHAS II cohort were: (i) able to be contacted by telephone and (ii) sufficient hearing and English language proficiency to be interviewed [27]. Among those screened, eligibility for participation in the full study was determined based on the following criteria: (i) self report of no difficulty in 15 tasks assessed or in only 1 domain of physical function among the following: mobility tasks, upper extremity tasks, household management tasks, and self-care tasks [28]. These criteria have been shown to identify the higher functioning of two thirds of older women [29]; (ii) intact cognitive function, assessed by Mini-Mental State Examination [30]. Scores higher than 24 on in-person interview, or scores higher than 80% in telephone administration of an abbreviated Mini-Mental screen (which excluded those questions which must be completed in person or were irrelevant (e.g., identification of the examination center location)); and (iii) ability to participate in a 1-day clinic examination in Baltimore, MD.

Among the 548 eligible women, 436 consented to participate in the extensive examination at the Johns Hopkins Hospital and to a prospective follow-up. Those agreeing did not differ significantly in disability characteristics from those who refused [31]. An interview standardized in the WHAS I was administered, to the WHAS II subjects, at the Johns Hopkins Functional Status Laboratory. A standardized examination and physical performance measures were also performed [31]. The Johns Hopkins Medical Institutions Institutional Review Board approved the research protocols. Written informed consent was obtained from all participants. More details of the design, recruitment, data collection methods, and extensive tabulations of baseline data have been previously published [32].

The analytic sample for this study included all women who underwent DXA evaluation (only done at round 4, performed 6 years after the beginning of the WHAS II), and that had available data on muscle and bone mass, as well as a known frailty status (n = 257). Women with a previous history of oral corticosteroids (N = 2) or bisphosphonates (N = 5) were excluded. Calcium and vitamin D use were not considered as criteria exclusion (Fig. 1).

Determination of frailty status

All women were categorized as frail, pre frail or robust according to a validated and widely used frailty screening criteria established by Fried et al. [33] in the Cardiovascular Health Study—CHS. These criteria are: 1) Shrinking: unintentional weight loss of ≥10 lb or of ≥5% of body weight in the prior year at follow-up (by direct weight measurement); 2) Weakness: grip strength in the lowest 20% at baseline adjusted for gender and body mass index; 3) Poor endurance and energy: as indicated by self-report of exhaustion, identified by two questions from the CES-D scale [34]; 4) Slowness: The slowest 20% of the population was defined at baseline, based on the time to walk 15 ft, adjusting for gender and standing height; and 5) Low physical activity level: The lowest quintile of physical activity based on each participant’s report with weighted score of kilocalories expended per week. Individuals with three or more of the five components were defined as frail, those with one or two components as pre frail, and those with none of the components as robust.

Body Mass Index (BMI)

Weight (kilograms) and height (meters) of all elderly women were measured by anthropometric balance and ruler at the same moment of DXA analysis. BMI was calculated as weight (kg)/height (m²). The patients with BMI less than 18.5 kg/m² were considered underweight and BMI equivalent to 30.0 kg/m² or more were obese [35].

Osteopenia and osteoporosis

Body composition and bone mineral density (BMD) of lumbar spine, femoral neck and total hip of all elderly women were obtained with the same densitometer with an X-ray source (DXA) DPX-L (LUNAR®). The coefficient of variation of the device was: 2.9% for the BMD of the lumbar spine; 3.2% for the total hip BMD and 1.8% for the femoral neck BMD. The elderly women were classified by the WHO (World Health Organization) criteria based on the BMD T score of the lumbar spine and/or femoral neck and/or total hip: normal (T score ≥−1 SD), osteopenic (T score between −2.5 SD and −1 SD), and osteoporotic (T score equivalent or lower than −2.5 SD) [36]. As our sample was derived from a population of high functioning elderly women, only a small number of subjects presented with osteoporosis. Based on this, we opted to classify our population into “severe” osteopenia (−2.5 SD<T score ≤−2.0 SD) and osteoporosis (T score ≤ −2.5 SD).

Sarcopenia and body fat mass

Total and regional lean and body fat mass were determined from a total body DXA with X-ray source (DXA) DPX-L (LUNAR®) at the same time as the BMD measurements. Coefficient of variation was 2.3% for total lean mass.

Sarcopenia was defined as proposed by Baumgartner [37–39] with appendicular lean mass (aLM) obtained as the sum of lean mass (LM) in arms and legs, assuming that all nonfat and nonbone tissue is skeletal muscle divided by the squared height (ht²)−(aLM/ht²). The cut point for elderly women was 5.45kg/m², equivalent to two standard deviations below a young reference population.

Covariates

Covariates were selected if they were felt to be related to frailty status, low bone mineral density or sarcopenia. The covariates used were: age, race, education (less than 12 years and more than 12 years), smoking (current smoking or if stopped less than 4 years prior to the interview) and diabetes (A1C ≥6.5% or fasting plasma glucose ≥ 126 mg/dl).

Statistical analysis

Descriptive statistics are reported as mean± standard deviation. Statistical analyses were performed with Stata 9.0 (StataCorp, College Station, TX). Data analysis: distribution of means, medians and proportions of variables of interest across frailty categories were compared using Wilcoxon, Chi-square and trend tests. Logistic
Regression using frailty as the dependent variable for groups of sarcopenia and severe osteopenia/osteoporosis and adjusted for covariates was performed.

**Results**

This study analyzed 250 elderly women who underwent total body DXA analysis at round 4 of WHAS II, 6 years after the beginning of the cohort. Mean age of study subjects was 79.6 (±2.7) years. The percentage of African Americans (AA) in the sample was 16% (n=40).

In multivariate models Caucasians had an increased likelihood of obesity compared to AA (OR: 2.3; 95% CI: 1.09–4.77; p=0.02). Frailty status was detected in 6.8% (n=17) of the elderly women, pre frailty in 47.6% (n=119) and robust in 45.6% (n=114). Frail elderly women were more obese (29.4%) than pre frail (24.3%) and robust (15.9%). In the total body DXA analysis, the frail group presented a higher percentage of total fat mass as compared to the pre frail and robust groups. Also, they were more likely to be less educated (p=0.09). There was no difference in the frequency of AA in frail (11.7%), pre frail (14.3%) and robust (17.5%). (Table 1).

![Flow chart of study design.](image)

**Table 1**

Characteristics of frail, pre frail and robust older women that underwent DXA analysis at round 4 - WHAS II.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frail (n=17)</th>
<th>Pre frail (n=118)</th>
<th>Robust (n=115)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean±SD) years</td>
<td>79.4±2.5</td>
<td>80.2±2.6</td>
<td>78.9±2.7</td>
<td>0.002</td>
</tr>
<tr>
<td>African Americans (%)</td>
<td>17.6%</td>
<td>14.4%</td>
<td>17.4%</td>
<td>0.555</td>
</tr>
<tr>
<td>Less than 12 years of education (%)</td>
<td>23.5%</td>
<td>23.1%</td>
<td>23.5%</td>
<td>0.091</td>
</tr>
<tr>
<td>BMI (mean±SD) (kg/m²)</td>
<td>27.40±6.3</td>
<td>26.97±5.4</td>
<td>26.33±4.4</td>
<td>0.519</td>
</tr>
<tr>
<td>Underweight (%)</td>
<td>11.7%</td>
<td>4.23%</td>
<td>0.86% (1)</td>
<td>0.042</td>
</tr>
<tr>
<td>Obesity (%)</td>
<td>29.42 (5)</td>
<td>24.63 (29)</td>
<td>16.54 (19)</td>
<td>0.263</td>
</tr>
<tr>
<td>Lumbar spine BMD (mean±SD) (g/cm²)</td>
<td>0.97±0.23</td>
<td>0.94±0.17</td>
<td>0.95±0.17</td>
<td>0.834</td>
</tr>
<tr>
<td>Neck BMD (mean±SD) (g/cm²)</td>
<td>0.65±0.11</td>
<td>0.68±0.12</td>
<td>0.67±0.10</td>
<td>0.544</td>
</tr>
<tr>
<td>Hip total BMD (mean±SD) (g/cm²)</td>
<td>0.82±0.13</td>
<td>0.86±0.15</td>
<td>0.87±0.13</td>
<td>0.487</td>
</tr>
<tr>
<td>Total fat mass (mean±SD) (kg)</td>
<td>26.31±10.5</td>
<td>24.93±8.2</td>
<td>24.70±7.4</td>
<td>0.758</td>
</tr>
<tr>
<td>Appendicular lean mass (mean±SD) (aLM) (kg)</td>
<td>14.18±2.4</td>
<td>14.20±2.1</td>
<td>14.32±2.2</td>
<td>0.903</td>
</tr>
<tr>
<td>aLM/ht² method (mean±SD) kg/m²</td>
<td>5.49±0.9</td>
<td>5.66±0.8</td>
<td>5.62±0.7</td>
<td>0.668</td>
</tr>
</tbody>
</table>

BMI—Body mass index (kg/m²).
BMD—Bone mineral density (g/cm²).
aLM—Appendicular lean mass (kg).

p values estimated the difference among the three groups (frail, pre frail and robust) (Anova test).
Osteopenia and osteoporosis

Although femoral neck and total hip BMD were lower in the frail group (Table 1), these were not found for the spine that had similar BMD in all groups. Elderly women with severe osteopenia/osteoporosis, when compared to women with higher BMD, were significantly more underweight (8.9% vs. 0.6%; \( p=0.001 \)); on the other hand, obese women were protected against severe osteopenia/osteoporosis (8.9% vs. 26.3%; \( p=0.002 \)). Additionally, women with severe osteopenia/osteoporosis had a tendency to be older than women with normal BMD (54.4% vs. 41.9%; \( p=0.051 \)). There was no significant difference in education, race, smoking status and the presence of diabetes between the groups. The total prevalence of osteoporosis was 18.4% (\( n=46 \)). In the frail elderly women group it was 23.5% (\( n=4 \)); in the pre frail group it was 17.8% (\( n=21 \)) and 18.3% (\( n=21 \)) in the robust group. Osteopenia occurred in 54.4% (\( n=136 \)) of the total population while in the frail group it was 52.9% (\( n=9 \)), 59.3% (\( n=70 \)) in the pre frail group and 49.6% (\( n=57 \)) in the robust group. Severe osteopenia was prevalent in 16.4% (n = 41) of the population study with 16.6% (n = 3) in the frail group, 17.1% (n = 20) in the pre frail, 15.7% (n = 18) in the robust. Almost thirty five percent (n = 87) of the elderly women had severe osteopenia/osteoporosis. In the frail, pre-frail and robust groups the prevalence of severe osteopenia/osteoporosis was: 41.2% (n = 7), 28.0% (n = 33) and 25.2% (n = 29), respectively (Table 2).

Sarcopenia

Sarcopenia was prevalent in 42.4% (\( n=106 \)) of the study population. In the frail group, sarcopenia occurred in more than a half of the subjects (52.9%; \( n=9 \)), and in lower proportion in the pre frail (42.37%; \( n=50 \)) and the robust groups (40.9%; \( n=47 \)) (Table 2). The highest proportion of sarcopenic women were Caucasians (92.5%; \( p=0.002 \)), and non obese (93.4%; \( p=0.000 \)), over 12 years of education (79.2%). Fifty percent were aged over 80 years and only 7.5% were underweight compared to the non sarcopenics. In a multivariate age adjusted model only obesity was a significant protector of sarcopenia (OR=0.15; 95% CI: 0.06–0.35; \( p=0.001 \)).

Severe osteopenia and osteoporosis with sarcopenia

Osteoporosis was prevalent in 26.2% of elderly women with sarcopenia (\( p=0.016 \)) and the presence of osteopenia was almost three times higher in the sarcopenic group (66.3% \( p=0.013 \)), when compared to non sarcopenics. Severe osteopenia and osteoporosis occurred in 40.2% in the sarcopenic (\( p=0.012 \)). Sarcopenia was identified in 58.3% of osteoporotics (\( p=0.016 \)) in 48.5% of osteopenics (\( p=0.04 \)) and in 54.4% of elderly women with severe osteopenia/osteoporosis (\( p=0.012 \)). Thirty percent of frail elderly women, 17.8% of pre frail and 14.8% of robust had severe osteopenia/osteoporosis and sarcopenia (Table 2).

In a logistic regression model adjusted for subjects aged 80 years or more, race, smoking, diabetes, education, body mass index and percentage of fat in the whole body scan, severe osteopenia/osteoporosis (OR: 2.1; 95% CI: 0.68–6.6, \( p=0.196 \)) and sarcopenia (OR: 3.1; 95% CI: 0.88–11.1; \( p=0.077 \)) were individually associated with frailty, though not statistically significant. On the other hand, the likelihood of being frail was substantially higher in the presence of both of these syndromes (OR: 6.4; 95% CI: 1.1–36.8, \( p=0.037 \)) (Table 2). In addition to this, no significant association between sarcopenia and severe osteopenia/osteoporosis with components of frailty related to the muscle mass (“weakness”, “slowness” and “low physical activity”) was found.

Discussion

Several studies have proposed that sarcopenia and osteoporosis are associated with frailty status. Nonetheless, recent literature has not been able to determine if this association is with low BMD and low appendicular lean mass individually or with the association of osteoporosis/sarcopenia. This study has shown that frail women had more sarcopenia and severe osteopenia/osteoporosis when compared to the pre frail and robust elderly women although this was not statistically significant. However, the joint impact of severe osteopenia/osteoporosis and sarcopenia had a six-time higher likelihood of frailty in community-dwelling older women.

Our findings of proximal femur and lumbar spine BMD are similar to other cohort studies with frail older men and women [6,14,15,19]. In a cross sectional analysis of a cohort study [14] with 6701 older women from the community, 16% were classified as frail by the Cardiovascular Health Study (CHS) criteria [33] and by the Study of Osteoporosis Fracture (SOF) [14] frailty criteria, i.e. 2 or more of the following 3 components: 1) weight loss (irrespective of intent to lose weight) of 5% or more between the third and fourth examinations (mean (SD) years between examinations, 2.0 SD (0.3)); 2) the subject’s inability to rise from a chair 5 times without using his/her arms; and 3) reduced energy level, as identified by an answer of “no” to the question “Do you feel full of energy?” on the Geriatric Depression Scale [40].

In the SOF study [14] frail elderly women presented with significant lower femoral neck BMD as compared to the other groups. However, the BMD values were very similar: 0.61 g/cm, 0.63 g/cm and 0.64 g/cm for the frail, pre frail and robust groups, respectively. Similar findings were observed in total hip BMD from 5993 elderly men (frail: 0.90 g/cm²; pre-frail: 0.95 g/cm² and robust 0.97 g/cm²) and femoral neck BMD (frail: 0.75 g/cm²; vs. pre frail: 0.78 g/cm²; vs. robust: 0.79 g/cm²) (16).

In our study, sarcopenia was more prevalent in the frail group than in the others groups, although not statistically significant. In the SOF [14] study sarcopenia was not evaluated, however, the mean of BMI between frail (26.2 kg/m² ± 5.4) pre frail (26.8 kg/m² ± 4.8) and robust (26.3 kg/m² ± 4.4) groups were very similar with a significant difference of muscle strength among frail, pre frail and robust. These findings may challenge the idea of a direct association between low

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Table 2

<table>
<thead>
<tr>
<th></th>
<th>Frail (n = 17)</th>
<th>OR* (95% CI)</th>
<th>Pre frail (n = 118)</th>
<th>OR* (95% CI)</th>
<th>Robust (n = 115)</th>
<th>OR p-value^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteopenia at lumbar spine and/or proximal femur (femoral neck and/or hip total) (%)</td>
<td>52.94 (9)</td>
<td>0.87 (0.36–2.54)</td>
<td>59.32 (70)</td>
<td>0.60 (0.34–1.05)</td>
<td>49.56 (57)</td>
<td>1.0 0.430</td>
</tr>
<tr>
<td>Osteoporosis at lumbar spine and/or proximal femur (femoral neck and/or hip total) (%)</td>
<td>23.52 (4)</td>
<td>2.39 (0.64–7.66)</td>
<td>17.79 (21)</td>
<td>2.63 (0.81–8.49)</td>
<td>18.26 (21)</td>
<td>1.0 0.068</td>
</tr>
<tr>
<td>Severe osteopenia/osteoporosis</td>
<td>41.17 (7)</td>
<td>2.1 (0.68–6.6)</td>
<td>27.96 (33)</td>
<td>1.70 (0.55–5.21)</td>
<td>25.21 (29)</td>
<td>1.0 0.257</td>
</tr>
<tr>
<td>Sarcopenia by aLM/h² method (%)</td>
<td>52.94 (9)</td>
<td>3.1 (0.88–11.1)</td>
<td>42.37 (50)</td>
<td>2.48 (0.79–7.74)</td>
<td>40.86 (47)</td>
<td>1.0 0.497</td>
</tr>
<tr>
<td>Sarcopenia by aLM/h² method and severe osteopenia/osteoporosis (%)</td>
<td>23.52 (4)</td>
<td>6.4 (1.1–36.8)</td>
<td>16.14 (19)</td>
<td>2.49 (0.72–8.55)</td>
<td>13.9 (16)</td>
<td>1.0 0.304</td>
</tr>
</tbody>
</table>

* Odds ratio after adjusting for age, Caucasian and years of education.

** Odds ratio after adjusting for BMI, age, Caucasian and years of education.

^ p values refers to the Chi square test of frequencies.
muscle mass and low muscle strength; this can probably be explained by the fact that other age related factors may contribute to the decreased muscle strength other than appendicular muscle mass. Previous studies have demonstrated a positive correlation among appendicular muscle mass (AMM) and BMD, decreased bending strength (lower section modulus) and lower cortical bones [41–43]. Physical activity has been positively associated with thigh muscle area, thigh muscle attenuation and appendicular lean soft tissue mass in women independent of age, race, study site, total body fat and height. In this same study, for the thigh muscle area and muscle attenuation, persons in the lowest (worst) quartiles showed higher risk of mobility limitation [44,45]. Moreover, low muscle mass is associated with low walking speed and balance [19], and increased risk of falls and disability [1,2,5,6,14,15] which are strongly associated with the frailty status [15,16,19].

The interaction of muscle mass with bone density and structure is complex and depends on molecular, physical and hormonal factors. The loss of muscle strength and mass during the aging process causes structural changes in the microarchitecture of the bones and decreases mineral density, resulting in bone quality decline and increased rate of fractures. Low intake of food, being underweight, having visceral protein depletion, low levels of albumin and 25-OH vitamin D have been linked to loss of bone mass [46] and muscle mass [47,48]. Decrease of strength and muscle mass has been described as an aging process [49] resulting from multiple causes, like neuronal loss [50], S-DHEA, testosterone, IGf-1, insulin growth factor [51], increased level of inflammatory cytokines [51–53], and low physical activity/immobilization [50]. At the cellular level, an age-related acceleration of myocyte loss, via apoptosis, might represent a key mechanism driving the onset and progression of muscle mass [54]. Further studies, with larger sample sizes are necessary to clarify if osteoporosis, osteopenia and sarcopenia, in an isolated fashion, are associated with frailty status in elderly women or if the association with frailty occurs only if an interaction of osteoporosis or osteopenia with sarcopenia exists.

This study has limitations. First, the small sample size may limit the interpretations of the results and further studies are necessary to confirm our data. Second, the study participants were recruited among high functioning community-dwelling women at baseline. In addition to this, these women had to survive for the 4th follow-up visit that occurred 7 years after baseline. In this context, and considering that sarcopenia and severe osteopenia/osteoporosis may have contributed to higher loss-to-follow-up rate, this may have biased our results towards an underestimation of the risk of frailty associated with sarcopenia and severe osteopenia/osteoporosis. Third, DXA scans present some limitations in the bone mineral density evaluation in elderly women, like aortic calcifications and spine osteoarthritics that may produce an increase, up to 10%, in BMD of the lumbar spine [55] and this could underestimate the real prevalence of low bone mass in this population and consequently, the association with frailty status.

Conclusions
Sarcopenia and severe osteopenia/osteoporosis were individually associated with frailty in elderly women from the community, but the observed associations did not reach statistical significance. On the other hand, when sarcopenia and severe osteopenia/osteoporosis were present, the likelihood of frailty was substantially enhanced.

Implications
Loss of bone and muscle mass is very common in older adults as a consequence of the aging process. The routine screening for osteoporosis recommends an evaluation of bone mineral density to all women aged 65 or more, and at age 60 years in women at increased risk of osteoporotic fractures. However, sarcopenia is not usually diagnosed as a routine screening in older population. The concomitant evaluation of bone mineral density and appendicular lean mass might be useful to evaluate the prevalence of sarcopenia and its consequences, like falls and disability. Furthermore, the concomitant diagnosis of sarcopenia and low bone mass may be useful to estimate the risk of frailty in this population as, in many cases, the evaluation of frailty criteria can be difficult in the daily clinical practice.

References


