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ORIGINAL CONTRIBUTION

Association of anorexia with sarcopenia in a community-dwelling elderly population: results from the *il*SIRENTE study

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Abstract
Objective There is increasing evidence that anorexia of aging can cause physical and mental impairment. The aim of the present study was to evaluate the relationship between anorexia and sarcopenia in elderly persons aged 80 years or older.
Methods Data are from the baseline evaluation of 354 subjects enrolled in the *ilSIRENTE* study. The *ilSIRENTE* study is a prospective cohort study performed in the mountain community living in the Sirente geographic area (L'Aquila, Abruzzo) in Central Italy. We defined anorexia as the presence of loss of appetite and/or lower food intake. According to the European Working Group on Sarcopenia in Older People (EWGSOP) criteria, diagnosis of sarcopenia required the documentation of low muscle mass plus the documentation of either low muscle strength or low physical performance. The relationship between anorexia and sarcopenia was estimated by deriving odds ratios from the multiple logistic regression models considering sarcopenia as the dependent variable.
Results Nearly 21 % of the study sample showed symptoms of anorexia. Using the EWGSOP-suggested algorithm, 103 subjects (29.1 %) with sarcopenia were identified. Thirty-four (46.6 %) participants were affected by sarcopenia among subjects with anorexia compared to 69 subjects [24.6 %] without anorexia ($p < 0.001$). After adjusting for potential confounders including age, gender, functional and cognitive impairment, physical activity, urinary incontinence, comorbidity, congestive heart failure, COPD, depression, anti-cholinergic drugs, and TNF-α plasmatic levels, participants with anorexia had a higher risk of sarcopenia compared with non-anorexic subjects (HR 1.88, 95 % CI 1.01–3.51).
Conclusions Anorexia is common among community-dwelling older subjects in Italy. Our results suggest that among old–old subjects, anorexia is independently associated with sarcopenia.

Keywords Anorexia · Sarcopenia · Frailty · *ilSIRENTE* study

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Introduction

Scientific evidence indicates that a significant number of frail elderly people fail to get proper amount of food necessary to meet essential energy and nutrient needs. Weight loss due to anorexia of aging has been mentioned as one of the most prevalent problem in older populations [1, 2] and is acknowledged as an independent predictor of morbidity and mortality among adult and geriatric patients in various clinical settings [3, 4]. In most cases, anorexia is associated with cachexia, poor endurance, impaired gait speed, and decreased mobility [5]. Furthermore, 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. Nonetheless, a number of issues

related to the consequences of anorexia in terms of physical performance, functional impairment, and possible interventions for elderly subjects with loss of food intake need to be addressed.

Anorexia of aging can lead to muscle wasting, decreased immunocompetence, depression, and an increased rate of disease complications. In particular, the decrease in food intake coupled with a decrease in exercise leads to a decline in muscle mass and strength [6]. On the other hand, sarcopenia plays an important etiologic role in the frailty process of elderly subjects, being also a key player of its latent phase and explaining many aspects of the frailty status itself [7]. Sarcopenia is frequently associated with poor endurance, physical inactivity, slow gait speed, and decreased mobility. These factors represent common features of the frailty syndrome [8]. Sarcopenia is also associated with an increased risk of incident disability and all-cause mortality in the elderly population [9]. In addition to these important clinical consequences, sarcopenia is related to increased health care costs [7].

Despite the growing importance of anorexia of aging, physical performance, and longevity in older persons, there is still a lack of information explaining whether and how they are related to each other. In the present study, we evaluated the relationship between anorexia and sarcopenia in elderly persons aged 80 years or older enrolled in the "Invecchiamento e Longevità nel Sirente" (Aging and Longevity in the Sirente geographic area, ilSIRENTE) study.

Methods

We conducted a cross-sectional study using data from the baseline assessment of the ilSIRENTE, a prospective cohort study that was performed in the mountain community living in the Sirente geographic area (L'Aquila, Italy) and developed by the teaching nursing home Opera Santa Maria della Pace (Fontecchio, L'Aquila, Italy) in partnership with local administrators and primary care physicians. The Catholic University of Sacred Heart ethical committee ratified the entire study protocol. All the participants signed an informed consent at the baseline visit. Details of the *ilSIRENTE* study protocol are described in details elsewhere [10].

Study population

A preliminary list of all persons living in the Sirente area was obtained at the end of October 2003 from the Registry Offices of the 13 municipalities involved in the study. From this preliminary list, potential study participants were identified by selecting all persons born before January 1, 1924 living in the Sirente area. Of the initial 514 subjects screened, 32 men and 53 women died or moved away from the area before the baseline assessment. Among those eligible ($n = 429$), prevalence of refusals was very low (16 %), without significant differences across gender or age groups. As a result, the overall study sample consisted of 364 subjects. The present analysis was conducted on 354 individuals, after excluding 10 participants with missing data respect to the main variables of interest. The Minimum Data Set for Home Care (MDS-HC) form was administered to all study participants, according to the guidelines published in the MDS-HC manual [11, 12]. The MDS-HC contains over 350 data elements including sociodemographics, physical and cognitive status variables, as well as major clinical diagnoses [11]. The MDS-HC also includes information about an extensive array of signs, symptoms, syndromes, and treatments [11].

Additional information about family history, lifestyle, physical activity, and behavioral factors was collected using specific questionnaires shared with the "Invecchiare in Chianti Study" [13].

Assessment of anorexia

At the baseline visit, two different single-item measures relative to food intake and appetite were administered to all participants [11]. Subjects were asked to answer to the question "Is the amount of food intake decreased in the last year?" rating as "No" or "Yes." The second question was "How is your appetite in general?" rating their status as "Poor," "Normal," or "Good." Anorexia status was defined as the presence of decreased food intake (answer "Yes" to the first question) or the presence of poor appetite (answer "Poor" to the second question).

Assessing anorexia in terms of reduced food intake is in accordance with the Nutrition-Day Audit Team suggestions that stated food intake may be considered a surrogate marker for anorexia [14, 15]. Furthermore, defining anorexia as a reduction and/or loss of appetite is in accordance with the recent European consensus definition of anorexia in chronic wasting diseases [6].

Assessment of sarcopenia

For the present study, we adopted the European Working Group on Sarcopenia in Older People (EWGSOP) criteria [16]. 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.

The EWGSOP suggests the muscle mass be evaluated using the DEXA or bioelectrical impedance analysis.

However, considering the type of the study, the muscle mass in our sample was measured by the mid-arm muscle circumference (MAMC). The MAMC was calculated using the following standard formula [17]: MAMC = mid-arm circumference—(3.14 × triceps skin-fold thickness). Measurement of triceps skin-fold thickness was performed using Harpenden skin-fold calliper. Mid-arm circumference was made using a flexible steel measuring tape, on the right side of the participant's body unless affected by disability or disease. For both of these two variables, the average of three measurements was computed [17]. In the absence of reliable cutoff points for European population, we considered the MAMC tertiles previously calculated on all subjects enrolled in the *ilSIRENTE* study [18]. The lower tertile identified the subjects with low muscle mass. As a consequence, low muscle mass was classified as MAMC less than 21.1 and 19.2 cm in men and women, respectively [18].

Walking speed was evaluated by measuring participants' usual gait speed (in m/s) over a 4-m course. As suggested in the EWGSOP consensus paper [16], a cutoff point of <0.8 m/s identifies subjects with low physical performance.

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, USA). 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 [16], low muscle strength was classified as hand grip less than 30 and 20 kg in men and women, respectively. These cutpoints were similar to that obtained from the InCHIANTI study population [19].

Covariates

Information on medical diagnoses and drugs consumed was directly collected from general practitioners. 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-HC form in a check-box section containing 27 specific diagnostic categories. We considered specific neurological medications and drugs with anticholinergic properties [20].

Basic and Instrumental Activities of Daily Living (ADL, IADL) were assessed using the MDS-HC instrument [11]. The ADL scale is based on seven levels of self-performance including dressing, eating, toilet use, bathing, mobility in bed, locomotion, and transfer. Similarly, the IADL scale is based on seven levels of self-performance including meal preparation, house work, managing finance, phone use, shopping, transportation, and managing medications. Cognitive performance was assessed using a six-item, seven-category scale (Cognitive Performance Scale—CPS) [11]. The CPS was scored on a 7-point ordinal scale in which higher scores were associated with worse cognitive performance. Behavioral problems were considered when at least one of the following symptoms occurred with a degree of intensity that is not responsive to family's attempts: wandering, verbally abusive symptom, physically abusive symptom, socially inappropriate behavior, and resistance to care.

Participants reporting light intensity aerobic exercise performed for at least 2–4 h per week during the last year were defined physically active. Body height was measured using a standard stadiometer. Body mass index (BMI) was defined as weight (kilograms) divided by the square of height (meters). Alcohol consumption was assessed by asking participants on the number of glasses of wine drunk during a standard day. Alcohol abuse was defined as a consumption of more than half of liter of wine per day. Current smoking was defined as the regular use of tobacco (at least once a week) in the last year.

Standard determinations of plasmatic albumin, cholesterol, and inflammatory markers (C-reactive protein, interleukin 6, TNF-α) were performed by commercially available kits (Olympus, Italy) suitable on Olympus 2700 instrumentation.

Statistical analysis

Characteristics of study participants were described according to the presence of anorexia at baseline assessment. Data were analyzed to obtain descriptive statistics. Continuous variables are presented as mean values ± standard deviation. Distributions of categorical variables were compared using the Fisher exact test. Differences between continuous variables were assessed by ANOVA comparisons for normally distributed parameters; otherwise, the Kruskal–Wallis test was adopted. A level of $p < 0.05$ was chosen for statistical significance.

The relationship between anorexia and sarcopenia was estimated by deriving odds ratios (ORs) and relative 95 % confidence intervals (CI) from multiple logistic regression models including sarcopenia as the dependent variable of interest. Variables showing significant differences in distribution ($p < 0.05$) between subjects with and without anorexia were included in the regression models. Final analyses were adjusted for age and gender (Model 1); age, gender, functional and cognitive impairment, physical activity, and urinary incontinence (Model 2); and age, gender, functional and cognitive impairment, physical activity, urinary incontinence, comorbidity, congestive heart failure, COPD, depression, anticholinergic drugs, TNF-α plasmatic levels (Model 3).

All analyses were performed by using SPSS software (version 10.1, SPSS Inc., Chicago, IL).

Table 1 Socio-demographic and functional characteristics of study participants according to the presence of anorexia at baseline assessment

	Total ($n = 354$)	No anorexia ($n = 281$)	Anorexia ($n = 73$)	p
Socio-demographic characteristics				
Age (years)	85.8 ± 4.9	85.6 ± 4.9	86.8 ± 4.6	0.05
Gender (female)	66.7	64.4	75.3	0.05
Marital status				
Married	27.7	29.2	21.9	0.42
Widowed	62.1	60.5	68.5	
Never married	10.2	10.3	9.6	
Living alone	29.4	29.4	29.6	0.54
Current smoking	2.3	2.1	2.7	0.51
Alcohol abuse	12.1	12.8	9.6	0.29
Physical activity	58.7	63.8	38.9	<0.001
Functional characteristics				
ADL	1.3 ± 2.4	1.2 ± 2.2	2.0 ± 2.8	0.01
IADL	3.0 ± 2.5	2.7 ± 2.5	3.8 ± 2.4	<0.01
Cognitive performance scale	0.8 ± 1.5	0.7 ± 1.2	1.1 ± 1.8	0.04
Behavior problems	3.1	2.5	5.5	0.17
Hearing impairment	22.9	22.1	26.0	0.28
Vision impairment	22.9	22.8	23.3	0.51
Pressure ulcer	2.5	1.8	5.5	0.09
Urinary incontinence	14.8	12.2	24.7	<0.01
Body mass index (kg/m^2)	25.6 ± 4.5	25.8 ± 4.1	24.8 ± 5.7	0.12
4-m walking speed (m/s)	0.48 ± 0.30	0.52 ± 0.30	0.33 ± 0.26	<0.001
Hand grip strength (kg)	30.3 ± 14.8	31.7 ± 14.5	25.0 ± 14.9	<0.01

Data are given as mean ± SD, or percentage

ADL activity of daily living and *IADL* instrumental activity of daily living scores: range 0–7, a higher number indicates higher impairment. Cognitive Performance Scale score: range 0–6, a higher number indicates higher impairment

Results

Main socio-demographic and functional characteristics of the sample population stratified according to the presence of symptoms of anorexia are shown in Table 1. Nearly, 21 % of the study sample showed symptoms of anorexia. Mean age of participants was 85.8 (SD 4.9) years (more than 20 % of the participants were aged 90 years and older). Women were predominant in our sample (67 %).

Overall, relative to non-anorexic subjects, participants with anorexia were older (mean age: 86.8 vs 85.6), have lower BMI (mean BMI: 24.8 vs 25.8), were more likely to be functionally impaired (ADL score: 2.0 vs 1.2, $p = 0.01$; IADL score: 3.8 vs 2.7, $p < 0.01$, respectively), and showed a higher level of cognitive impairment (mean CPS score: 1.1 vs 0.7, $p = 0.04$, respectively).

As shown in Table 2, compared to subjects without anorexia, those with anorexia had a higher number of diseases (mean number of comorbid conditions: 2.2 vs. 1.8, $p = 0.04$, respectively). In particular, several health conditions (depression, congestive heart failure, lung disease) were more common among participants with anorexia. Medications with anticholinergic properties were more frequently used by subjects with anorexia compared to subjects without anorexia (53 vs 35 %, $p < 0.01$, respectively). Among inflammatory markers considered, only TNF-α serum level was higher in subjects with anorexia than in subjects without anorexia (mean value: 2.4 vs 1.8 pg/ml, $p = 0.03$, respectively).

Using the EWGSOP-suggested algorithm [16], one hundred and three subjects (29.1 %) with sarcopenia were identified (Fig. 1). No difference between men and women was observed (27.1 vs 30.1 %, $p = 0.32$, respectively). Thirty-four (46.6 %) participants were affected by sarcopenia among subjects with anorexia compared to 69 subjects (24.6 %) without anorexia ($p < 0.001$). Results from unadjusted and multiple logistic regression models are shown in Table 3.

In the unadjusted model, there was a direct association between anorexia and sarcopenia (OR 2.67, 95 % CI 1.57–4.56). Similarly, this association was consistent both in male (OR 3.34, 95 % CI 1.19–9.42) and female (OR 2.44, 95 % CI 1.30–4.58) subjects. After adjusting for potential confounders, such association remained statistically significant although somewhat less strong than that derived from the crude analysis (Table 3). In the fully adjusted model, participants with anorexia had a nearly twofold increased risk of sarcopenia compared with non-anorexic subjects (OR 1.88, 95 % CI 1.01–3.51).

Finally, a subgroup analysis restricted to individuals with no weight loss and BMI higher than 20 kg/m^2 has been performed in order to examine the association between anorexia and sarcopenia, independently of weight loss and BMI. After excluding 20 (5.6 %) participants with significant weight loss (more than or equal to 10 % during the last 6 months before the baseline assessment), relative to non-anorexic subjects, those with anorexia showed a significantly higher risk to be sarcopenic (OR 1.97, 95 % CI 1.09–3.58). Finally, after excluding 43 (12.1 %) participants with BMI lower that 20 kg/m^2, subjects with

Table 2 Clinical characteristics of study participants according to the presence of anorexia at baseline assessment

	Total ($n = 354$)	No anorexia ($n = 281$)	Anorexia ($n = 73$)	p
Clinical conditions				
Number of diseases	1.9 ± 1.2	1.8 ± 1.1	2.2 ± 1.5	0.04
Coronary heart disease	11.9	12.1	11.1	0.48
Congestive heart failure	5.6	4.3	11.0	0.03
Hypertension	72.6	73.3	69.9	0.32
Cerebrovascular disease	4.5	4.6	4.1	0.57
COPD	13.8	11.7	21.9	0.02
Diabetes	29.1	27.8	34.2	0.17
Depression	25.4	22.4	37.0	0.01
Parkinson's disease	1.7	1.8	1.4	0.64
Osteoarthritis	19.5	20.3	16.4	0.28
Renal failure	0.8	0.7	1.4	0.50
Cancer	4.8	4.3	6.8	0.26
Medications				
Number of drugs	3.2 ± 2.1	3.2 ± 2.1	3.5 ± 2.2	0.26
Antipsychotic	2.5	2.1	4.1	0.27
Antidepressant	5.9	5.7	6.8	0.44
Anticholinergic drugs	39.0	35.2	53.4	<0.01
Hematological parameters				
Albumin (g/dl)	4.1 ± 0.3	4.1 ± 0.3	4.1 ± 0.3	0.57
Cholesterol (mg/dl)	197.0 ± 45.0	197.2 ± 43.5	195.9 ± 50.6	0.81
C-reactive protein (mg/dl)	4.1 ± 3.4	4.2 ± 3.3	3.7 ± 3.8	0.28
Interleukin-6 (pg/ml)	2.8 ± 2.5	2.8 ± 2.5	3.1 ± 2.6	0.27
TNF-α (pg/ml)	1.9 ± 2.2	1.8 ± 2.0	2.4 ± 2.7	0.03

Data are given as mean ± SD, or percentage

COPD chronic obstructive pulmonary disease

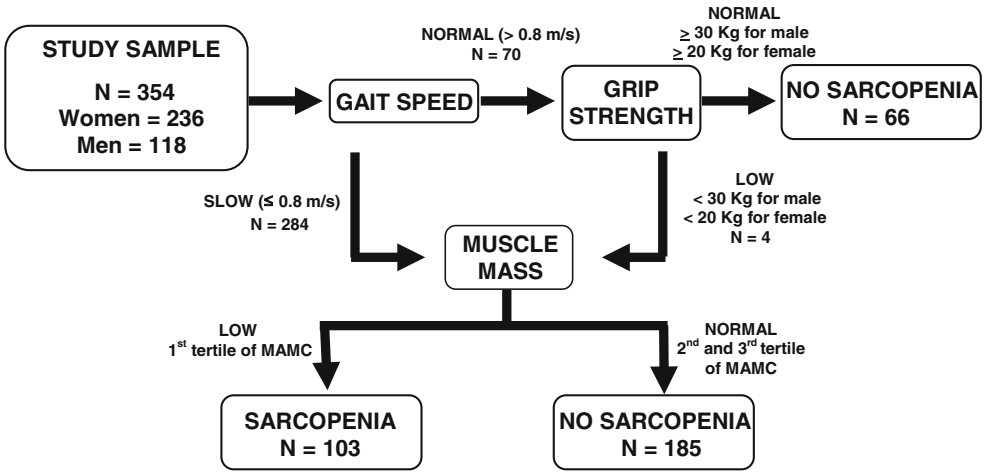

Fig. 1 EWGSOP-suggested algorithm for sarcopenia case finding

anorexia showed a significantly higher risk to be sarcopenic (OR 1.89, 95 % CI 1.01–3.55).

Discussion

In the present study, we explored the association of anorexia with sarcopenia. Our findings show that, in older persons, sarcopenia is correlated with the presence of anorexia, independently of clinical evidence of malnutrition (i.e., weight loss and BMI lower than 20 kg/m^2).

The regulation of food ingestion is an extremely complex process, with multiple fail-safe mechanisms in place to ensure that the feeding drive remains intact. Food intake can be considered to be under the regulation of a central feeding drive that is held in check by a peripheral satiation

Table 3 Association between anorexia and sarcopenia, after adjustment for various confounders

	Unadjusted Risk of sarcopenia	Model 1	Model 2	Model 3
	Odds ratios [95 % confidence interval]			
Anorexia	2.67 [1.57–4.56]	2.46 [1.42–4.27]	2.01 [1.09–3.68]	1.88 [1.01–3.51]
Age		1.10 [1.05–1.15]	1.05 [0.99–1.11]	1.05 [0.99–1.11]
Gender (female)		1.11 [0.66–1.86]	0.99 [0.57–1.73]	1.05 [0.58–1.90]
ADL impairment			1.16 [0.97–1.38]	1.13 [0.94–1.35]
IADL impairment			0.99 [0.83–1.19]	0.98 [0.81–1.19]
Cognitive impairment			1.04 [0.84–1.28]	1.03 [0.83–1.29]
Physical activity			0.54 [0.26–1.10]	0.54 [0.25–1.14]
Urinary incontinence			0.79 [0.73–4.39]	1.85 [0.74–4.60]
Comorbidity				1.08 [0.85–1.37]
Congestive heart failure				1.38 [0.48–3.95]
COPD				1.35 [0.61–3.00]
Depression				0.96 [0.50–1.82]
Anticholinergic drugs				1.39 [0.78–2.47]
TNF-α				1.04 [0.93–1.16]

system. The central feeding system receives further feedback from peripheral fat cell signals, nutrients, and circulating hormones. Studies have suggested that alterations at multiple levels of this system occur with aging, resulting in the physiologic anorexia of aging [21]. Mechanisms involved in the age-related decline in appetite and food intake are multifactorial and not completely understood. Physical, emotional, social, cultural, and financial factors all interact in the control of food intake. The major risk factors of anorexia are the aging process itself, biological changes, behavioral factors, social and environmental conditions, many acute and chronic diseases and treatments [22, 23].

Various studies have demonstrated a strong correlation between anorexia, functional impairment, morbidity, and mortality [18]. More recently, anorexia per se has been shown to be an independent predictor of mortality [15]. Numerous clinical consequences observed in frail elderly subjects are correlated with anorexia: impaired wound healing, impaired immune response to infections, hypoalbuminemia, increased synthesis of acute phase proteins such as C-reactive protein, alpha-1 acid glycoprotein, and fibrinogen, decreased coagulation capacity, reduced gut function, intestinal bacterial translocation, muscle wasting, decreased function of respiratory muscles [20]. Furthermore, anorexia is highly predictive of incident disability, poor quality of life, and all-cause mortality [6, 24, 25].

Anorexia is strongly associated with higher risk of quantitative malnutrition due to low-calorie intake. On the other hand, anorexia—especially in the early stage—may be correlated with a high risk of qualitative low intake of single nutrients, in particular, protein and vitamins [6]. It could be hypothesized that this selective malnutrition—for example, in terms of single macro- or micronutrients—is directly correlated with the onset of sarcopenia. Our results, showing a correlation between anorexia and sarcopenia in the subjects without clinical evidence of malnutrition, support this hypothesis. Furthermore, some recent studies documented the strong correlation between specific nutritional deficit—leucine and/or vitamin D—with sarcopenia [26, 27]. In this respect, it is important to highlight that nutrition remains important throughout life. Earlier poor nutrition habits influence many chronic diseases that develop late in life. Some studies have documented that a "good" diet helps both in reducing the risk of diseases and in managing the diseases' signs and symptoms [21, 28]. This contributes to a better quality of life, enabling older people to maintain their independence and physical performance. On the other hand, poor nutrition and anorexia can prolong recovery from acute illnesses, increase the rate of institutionalization, expand the costs of health care, and lead to a poorer quality of life [6, 22]. The loss of muscle mass could be the link between anorexia, malnutrition, and negative outcomes in frail elderly subjects.

Some methodological issues should be taken into account in the interpretation of results. The cross-sectional design of the study does not permit to clarify any cause–effect mechanism. The *ilSIRENTE* study gives us the opportunity to adjust our analyses for many health and disease-related characteristics that are potentially correlated with the anorexia. In this respect, it is important to highlight that the results were robust to adjustments for these numerous potential confounders. Second, results may be confounded by unmeasured factors, in particular preventive or specific health care interventions. However, our homogeneous population of old people born and living in a well-defined geographic area minimizes the possibility that

subjects without anorexia had substantially better health care or health knowledge than those with anorexia. Third, we lack some potential important information that could better explain the relationship between anorexia and sarcopenia; we have no data about the type and the total amount of daily food intake, and the distribution in terms of proteins, lipids, and carbohydrates. However, we were interested in characterizing the correlation of anorexia itself with sarcopenia. Furthermore, many experts in sarcopenia believe that anthropometric measures are poor markers of muscle mass and cast doubts on their role in this kind of studies [16]. However, as previously demonstrated by Wannamethee et al. [29], MAMC—as a marker of muscle mass—provides a simple measure of body composition. Considering the type of study, it was not possible to assess the muscle mass using the DEXA or the bioelectrical impedance analysis. About the mid-arm circumference assessment, recent protocol suggests to perform the trials on non-dominant arm, in order to detect the risk of malnutrition at an early stage. Using the right arm may have led to an overestimate of muscle mass. Finally, it is important to underline that the *il*SIRENTE sample population consisted of persons aged 80 years or older, so our results may not be applicable to other age groups.

The *il*SIRENTE study offers a unique opportunity to investigate the biological and non-biological determinants of active aging and longevity, as well as their interactions, among old–old and frail subjects, which frequently are excluded from epidemiological studies. Identification of these factors may help to target specific interventions aimed to prevent physical impairment and disability in late life. In this respect, it is important to highlight that being aware of the presence and/or the risk of anorexia can help to reduce the potential for anorexia side effects and eventually to prevent sarcopenia and functional impairment.

In conclusion, the present study shows that the anorexia is common among community-dwelling older subjects in Italy. Our results suggest that among old–old subjects, the presence of anorexia is associated with sarcopenia, as assessed by means of European Consensus. Scientific evidence indicates that a significant number of elderly fail to get proper amount and specific types of food necessary to meet essential energy and nutrient needs [6, 30]. Anorexia is not an inevitable side effect of aging, but many changes associated with the process of aging can promote it. Physiologic, psychological, and economical changes may have considerable effects on nutritional habits and status. Establishing healthy nutritional habits often requires a multifaceted intervention approach. Optimizing the nutritional status may decrease the risk of functional decline and sarcopenia in the elderly population. Prospective studies investigating the effect of specific nutritional intervention on the risk of sarcopenia in larger populations are needed to provide definitive evidence for clinical guidelines.

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Conflict of interest None.

Appendix

The *ilSIRENTE* Study Group is composed as follows:

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