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Original article

Calf circumference, frailty and physical performance among older adults living in the community

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SUMMARY

Background & aims: Lean body mass loss has been indicated as a reliable marker of frailty and poor physical performance among older individuals. We evaluated the relationship between calf circumference and frailty, physical performance, muscle strength, and functional status in persons aged 80 years or older.

Methods: Data are from the baseline evaluation of the Aging and Longevity Study in the Sirente geographic area (ilSIRENTE Study) ($n = 357$). The calf circumference was measured at the point of greatest circumference. Frailty was categorized according to the present of slow gait speed, weakness, weight loss, energy expenditure and exhaustion. Physical performance was assessed using the physical performance battery score, which is based on three timed tests: 4-m walking speed test, the balance test and the chair stand test. Analyses of covariance were performed to evaluate the relationship between different calf circumference and physical function.

Results: After adjustment for potential confounders, which included age, gender, education, body mass index, sensory impairments, cerebrovascular diseases, albumin, reactive C protein, interleukine-6, and cholesterol, physical performance (SPPB score: 7.27 versus 6.18, $p = 0.02$) and muscle strength (Hand Grip: 32 kg versus 28 kg, $p = 0.03$) measures significantly improved as calf circumference increased. The frailty index score was significantly lower among subjects with higher calf circumference (1.66 versus 2.17, $p = 0.01$).

Conclusions: The present study suggests that among community-dwelling older people, calf circumference may be positively related to lower frailty index and higher functional performance. As such, calf circumference is a valuable tool for guiding public health policy and clinical decisions.

1. Introduction

Aging process is related with significant changes in body composition, with a decline in lean body mass and an increase in visceral fat mass.[1] Loss of muscle mass is associated with poor physical performance, physical inactivity, slow gait speed and decreased mobility. These factors are recognized as common features of the frailty syndrome.[2,3] The age-related muscle mass loss is also associated with an increased risk of incident disability and all-cause mortality in the elderly population.[4,5]

According to Fried and colleagues,[2] loss of lean body mass has a significant part in the frailty progression of older subjects, being also an important player of its latent stage and explaining some characteristics of the frailty status itself.[6] The dual energy X-ray absorptiometry (DEXA) and the bioelectrical impedance analysis (BIA) are common methods to assess the lean body mass and the skeletal muscle mass.[7] On the other hand, DEXA and BIA may not be accessible and their utilization among older subjects may be limited. In this respect, anthropometric measurements could be very practical for the clinical assessment of nutritional status and sarcopenia in frail older people.[4,8] Anthropometry offers the single most portable, universally applicable, inexpensive and non-invasive technique for assessing the size, proportions and composition of the human body. For these reasons, anthropometric data are used in many contexts to screen for or monitor disease among child and young subjects. On the contrary, anthropometry is a

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relatively less used and thus difficult to evaluate among older subjects. Previously, several studies have documented that mid-arm muscle circumference reflects both health and nutritional status and predicts performance, health and survival.[4,8,9]

Despite research growing interest, information on how anthropometric data, physical performance and frailty may be related to each other is still lacking. In the present study, we evaluated the relationship between calf circumference and physical performance (4-m walking test, Short Physical Performance Battery), muscle strength (hand grip strength), functional status (Basic and Instrumental Activities of Daily Living) and frailty (based on Fried criteria) in a population of persons aged 80 years or older enrolled in the "Invecchiamento e Longevità nel Sirente" (Aging and longevity in the Sirente geographic area, ilSIRENTE Study) study.

2. Methods

We used data from the ilSIRENTE, a prospective cohort study conducted in the mountain community living in the Sirente geographic area (L'Aquila, Italy). The Catholic University of Sacred Heart ethical committee ratified the entire study protocol. All the participants signed an informed consent at the baseline visit. The ilSIRENTE study protocol is described in details elsewhere.[10]

2.1. Study population

A preliminary list of all persons living in the Sirente area was obtain 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 1st January 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 sample population enrolled in the ilSIRENTE study consisted of 364 subjects.

The present analysis was conducted among 266 subjects, after exclusion of 89 participants with peripheral signs of edema and 9 subjects with missing data for the main variables of interest. The participants excluded were similar to the sample considered for the present study in terms of age, gender, socio-demographic and clinical characteristics.

2.2. Data collection

The Minimum Data Set for Home Care (MDS-HC) form was administered to all study participants, following the guidelines published in the MDS-HC manual.[11] The MDS-HC contains over 350 data elements including socio-demographics, physical and cognitive status variables, as well as major clinical diagnoses.[11] Moreover, the MDS-HC also includes information about an extensive array of signs, symptoms, syndromes, and treatments.[11] A variety of different, multi-item summary scales are embedded in the MDS-HC measuring, including the Cognitive Performance Scale (CPS).[12] The MDS items have shown an excellent inter-rater and test–retest reliability when completed by nurses performing usual assessment duties.[13] Additional information about family history, lifestyle, physical activity and behavioral factors were collected using specific questionnaires shared with the "Invecchiare in Chianti Study".[14]

2.3. Calf circumference

Anthropometric measures were performed at baseline using a non-elastic but flexible plastic tape. Calf circumference was measured on the left leg (or the right leg for left-handed persons) in a sitting position with the knee and ankle at a right angle and feet resting on the floor. The calf circumference was measured at the point of greatest circumference. Subcutaneous tissues were not compressed. In a previous study,[15] anthropometric measures have shown an excellent reliability when performed by expert personnel. A cut-point of less than 31 cm was considered lower muscle mass, as previously described by Rolland and colleagues[16]; this cut-off point has been established for the elderly by the WHO Expert Committee.[17]

2.4. Frailty index

As measured by Fried and colleagues,[2] frailty was categorized according to the following characteristics: (a) slow gait speed (a cut-off point of <0.8 m/s identifies subjects with slow gait speed); (b) weakness (low muscle strength was classified as hand grip less than 30 kg and 20 kg in men and women, respectively); (c) weight loss (unintended weight loss of 5% or more in the last 30 days or 10% or more in the last 6 months); (d) energy expenditure (less that one hour per week of activities – such as walking, dancing, or gardening – during the last year identified physically inactive subjects); (e) exhaustion (difficult to take a walk with ups and downs). Accordingly, frailty index score has been calculated, ranging from 0 to 5. Frailty severity increases with the accumulation of more frailty criteria (0 = no frail, 5 = frail).

2.5. Physical performance measures

Physical performance was assessed using the 4-m walking speed and the Short Physical Performance Battery (SPPB) score. The SPPB is composed by three timed tests: the walking speed test, the balance test and the chair stand test.[18] Walking speed was evaluated measuring participants' usual gait speed (in m/sec) over a 4-m course. To assess the balance test, participants were asked to perform three increasingly challenging standing positions: side-by-side position, semi-tandem position, and tandem position. Participants were asked to hold each position for 10 s. To assess the chair stand test, participants were asked to stand up from a chair with their arms folded across the chest five times in a row as quickly as possible. The time needed to complete the task was recorded. Timed results from each test were rescored from 0 (worst performers) to 4 (best performers). The sum of the results from each test (ranging from 0 to 12) as previously described and validated was used in the present analysis.[18] The SPPB score adopted in the ilSIRENTE study has already proved a powerful tool for health research.[4] Furthermore, this measure has shown to be a valid and reproducible measure that can discriminate small and clinically meaningful differences in physical function and to be predictive of different forms of disability and among older adults.

2.6. Muscle strength measure

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.

2.7. Functional status measures

Basic and Instrumental Activities of Daily Living were assessed by the assessor 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