ARTICLE IN PRESS

JAMDA xxx (2014) 1–6

JAMDA

journal homepage: www.jamda.com

Original Study

Dynapenic Obesity and Lower Extremity Function in Elderly Adults

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Keywords:
Dynapenia
dynapenic obesity
gait speed
mobility disability

ABSTRACT

Objectives: Little is known about the relationship between dynapenic obesity and physical function in older Asian populations. This study aimed to examine the relationship of dynapenic obesity and lower extremity function in Chinese elderly adults.
Methods: Data were from a cross-sectional study (n = 616). Based on the World Health Organization Asian Criteria of Obesity and handgrip strength tertiles, 4 independent groups were classified as follows: nondynapenia/nonobesity, dynapenia-alone, obesity-alone, and dynapenic obesity. Lower extremity function was evaluated with a 20-meter gait speed test, balance test, and self-reported mobility disability.
Results: Compared with the dynapenic obesity group, the adjusted odds ratios (ORs) and 95% confidential intervals (CIs) for slow gait speed in men were 0.55 (0.27–0.86) in the nondynapenia/nonobesity group, 0.78 (0.31–0.96) in the dynapenia-alone group, and 0.86 (0.16–0.95) in the obesity-alone group. The corresponding ORs (95% CIs) in women were 0.46 (0.27–0.71), 0.80 (0.17–0.93), and 0.73 (0.15–0.91), respectively. Compared with the dynapenic obesity group, the adjusted ORs (95% CIs) for mobility disability in men were 0.41 (0.26–0.62) in the nondynapenia/nonobesity group, 0.61 (0.16–0.85) in the dynapenia-alone group, and 0.72 (0.28–0.88) in the obesity-alone group. The corresponding ORs (95% CIs) in women were 0.37 (0.17–0.81), 0.51 (0.27–0.96), and 0.53 (0.26–0.83), respectively. No significant difference was observed among the 4 groups with respect to the balance test score in both sexes ($P < .01$).
Conclusions: Dynapenic obesity was associated with a greater risk of slow gait speed and mobility disability compared with dynapenia-alone or obesity-alone.
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With advancing age, the prevalence of disability increases, which significantly influences quality of life and survival for older adults.[1] Lower extremity function is essential for many activities of daily living (ADLs) that are necessary for independent life. Thus, the impairment of lower extremity function is one of the key factors of developing disability.[2]

Impaired lower extremity function can be caused by many factors, such as obesity and low muscle strength.[3] Numerous cross-sectional studies and longitudinal studies have revealed the association between obesity and impaired lower extremity function.[3] In addition, some studies have found that lower muscle strength also is independently associated with impaired lower extremity function.[4,5] Recently, the term "dynapenia" has been coined to describe the age-related loss of muscle strength by Clark and Manini.[6]

Because obesity and dynapenia are each related to impaired lower extremity function, older adults with the combination of these 2 conditions, which is referred to as "dynapenic obesity," theoretically would have a poorer lower extremity function than those with obesity or dynapenia alone. Several studies have examined this hypothesis.[7–9] In longitudinal studies, older adults with obesity in the lowest leg strength tertile were found to have a greater decline in lower extremity function than the other participants.[9] In another cross-sectional study, the prevalence of walking limitation was reported to be higher in older adults with a high body fat percentage and low handgrip strength than in those with a low body fat percentage and high handgrip strength.[7] More recently, Bouchard and Janssen[8] conducted a cross-sectional study with 2039 individuals aged 55 years and older, and found that dynapenic obesity was associated with a greater impairment of lower extremity function than obesity alone, and in most cases with dynapenia alone.

Obesity has become a main public health problem in China and has drawn much attention from researchers[10]; however, little is known about dynapenia, dynapenic obesity, and their effects on

This study was funded by the National Department Public Benefit Research Foundation of the Ministry of Health P. R. China (no. 201002011). The sponsor had no role in the design, methods, data collection, analysis, or preparation of the paper.
The authors declare no conflicts of interest.
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1525-8610/$ - see front matter © 2014 AMDA – The Society for Post-Acute and Long-Term Care Medicine.
http://dx.doi.org/10.1016/j.jamda.2014.06.019.

function in the Chinese population. To the best of our knowledge, no study has investigated the effect of dynapenic obesity on lower extremity function in Chinese elderly adults. Therefore, we conducted this study to examine the potential relationship of obesity, dynapenia, and dynapenic obesity with lower extremity function in a sample of the older Chinese population.

Methods

Study Population

This cross-sectional study, designated the "the Comprehensive Geriatric Assessment and Health Care Service System in Chinese Elderly Project," was conducted in 2 cities (Chengdu and Suining) in China from October 2010 to August 2012. We recruited 887 community-dwelling adults aged 60 years and older. The study protocol was approved by the Research Ethics Committee of Sichuan University and informed consent was obtained from all the participants (or their legal proxies). Trained interviewers visited and evaluated all the study subjects at their homes or community centers for data collection. All interviewers were trained by using investigation manuals, multimedia materials, and simulated patients. Each interviewer was required to pass a test before the formal investigation. The anthropometric measurements were performed by trained personnel, and biological specimens were collected.

Anthropometric Measures

The waist circumference (WC) was measured using a steel measuring tape (Reynolds, Baofeng, Inc, Ningbo, China) to the nearest 0.1 cm. The measurement was performed on bare skin following a light exhalation, with the person standing. Body height and weight were measured using a wall-mounted stadiometer and a digital floor scale to the nearest 0.1 cm and 0.1 kg, respectively. The body mass index (BMI) was then calculated as weight (kg) divided by height (m) squared.

Measurement of Handgrip Strength

We applied a handheld dynamometer based on strain gauge sensors (EH101; Xiangshan, Inc, Guangdong, China) to measure handgrip strength (in kilograms). Both hands were measured with the participant seated, elbow flexed at a 110° angle, with the wrist in a neutral position, and the interphalangeal joint of the index finger at a 90° angle. Two readings were taken, and the highest value was used for the analysis. We conducted a preliminary study to assess the reliability of the handgrip strength test using the intraclass correlation coefficient (ICC). The results indicated that the test-retest reliability of the handgrip strength test was excellent (ICC = 0.85, n = 115).

Classification of Obesity, Dynapenia, and Dynapenic Obesity

The participants were grouped to represent the nonobesity group ($<$25 kg/m^2) and the obesity group ($\geq$25 kg/m^2) based on the World Health Organization Asian Criteria of Obesity.[11]

In this study, we applied handgrip strength to define dynapenia for 3 reasons. First, although handgrip strength is recommended as a screening test for defining dynapenia, whereas knee extensor strength is recommended as an advance test for defining dynapenia,[12] a well-established consensus has not been reached. Second, handgrip strength has been proven to be a good indicator of whole-body strength.[13] Low handgrip strength is consistently associated with an increased risk of complications, mortality, and the development of mobility disability.[13] Furthermore, a previous study indicated that handgrip strength provided risk estimates similar to those of quadriceps strength.[14] Third, compared with knee extensor strength, handgrip strength is much easier to measure, and the device is significantly cheaper and, therefore, is more affordable for medical institutions in developing countries such as China.

To the best of our knowledge, there remains no well-accepted cutoff points for handgrip strength to define dynapenia. In this study, we defined people in the lowest tertile of sex-specific and age-adjusted handgrip strength as dynapenia. This method has been used in previous studies.[8,15] Because muscle strength significantly differs by age and gender,[16] the handgrip strength values were regressed to a full cubic polynomial by age (age, age,[2] and age[3]) in the within-sex subgroups using a forward stepwise regression. The standardized residuals were retained to represent the age-adjusted values.[8] The sex-specific tertiles of handgrip strength were calculated, and the individuals in the lowest tertile of handgrip strength were classified as dynapenic, whereas those in the second and the third tertiles were classified as nondynapenic.

According to sex-specific age-adjusted handgrip strength and BMI, the participants were then classified into 4 groups: dynapenia-alone, obesity-alone, dynapenic obesity, and nondynapenia/nonobesity.

Measurement of Lower Extremity Function

The lower extremity function of each participant was assessed using both objective and subjective measures.

The objective measures included usual gait speed and balance test. To test the usual gait speed, participants were asked to walk 20 meters at a typical pace, and the time (in seconds) to complete the test was recorded.[17] Participants were allowed to use canes or walkers if necessary. Slow gait was defined as the lowest quartile ($<$1.05 m/s). For the balance test, participants were asked to stand in 3 progressively more difficult positions for 10 seconds each: a side-by-side stance, a semitandem stance, and a full-tandem stance. Participants were scored 0 if they could not hold the side-by-side stance for 10 seconds, 1 if they could hold the side-by-side but not the semitandem stance for 10 seconds, 2 if they could hold the semitandem stance for 10 seconds but could not hold the full-tandem stance for more than 2 seconds, 3 if they could hold the full-tandem stance for 3 to 9 seconds, and 4 if they could hold the full-tandem stance for 10 seconds.[18]

The subjective measures included 2 questions that asked participants to rate their difficulty walking for a quarter of a mile and climbing 10 steps without resting. The response options for each question were as follows: no difficulty (1 point), some difficulty (2 points), and unable to perform (3 points). Self-reported mobility disability was defined as an inability to walk a quarter of a mile or to climb 10 steps without resting.[19]

Assessment of Covariates

The following covariates were included in the analyses: age, gender, alcohol drinking status (current drinker, former drinker, and nondrinker), smoking status (current smoker, former smoker, and nonsmoker), and education level (less than high school, high school, and more than high school). In addition, self-reported physical activity was evaluated by asking the participants about the frequency and duration of physical activities of at least moderate intensity in the previous month. According to this information, the participants were classified into 3 groups (none, $<$30, $\geq$30 minutes per day). Furthermore, the following chronic diseases were assessed by trained interviewers by using a self-reported questionnaire: visual problems, hearing problems, arthritis, diabetes, lung disease (chronic

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