The Journal of Nutrition, Health & Aging©
Volume 15, Number 10, 2011

ARE CURRENT DEFINITIONS OF SARCOPENIA APPLICABLE FOR OLDER CHINESE ADULTS?

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Abstract: This study aims to explore whether the current definitions of sarcopenia are applicable to the older Chinese population. Participants were 783 Chinese adults recruited from four regions in Mainland China: Jinan, Guangzhou, Xi'an, and Chengdu. Body composition was measured by dual energy x-ray absorptiometry. Handgrip strength, body weight, and height were measured by trained technicians, and demographic data were collected through questionnaires. Relative appendicular skeletal muscle, skeletal muscle index (SMI=100 × skeletal muscle mass/ body mass) and residuals methods were applied to identify sarcopenia. Compared with young adults, no significant decrease was found in the relative appendicular skeletal muscle (ASM/height^2) in older adults. If the criterion of two standard deviations below the mean value of ASM/height^2 in young adults is used, none of older adults in this study could be diagnosed with sarcopenia. In addition, compared with the ASM/height^2 and residuals methods, SMI shows higher discriminating power in the identifying persons with low handgrip strength. The data suggest that ASM/height^2 method may not be appropriate for diagnosis of sarcopenia in Chinese population. However, whether SMI is a better choice remains inconclusive. Prospective studies are needed to clearly define sarcopenia in Chinese population.

Key words: Sarcopenia, aging, handgrip, appendicular skeletal muscle.

Introduction

Sarcopenia is a geriatric syndrome characterized by the loss of skeletal muscle mass and strength with advancing age (1). Sarcopenia may lead to some adverse consequences including decrease in balance, falls, fractures, weakening of endurance capacity, physical disability, poor quality of life, and increased mortality (2–5). The direct healthcare cost for sarcopenia in the United States was estimated to be USD 18.5 billion in 2000 (6). Therefore, establishing a valid definition of sarcopenia is very important to translate the concept from a research setting to the clinical area (4).

Although a variety of studies have been conducted during the past 10 years, a widely accepted definition for sarcopenia remains lacking (7). The first definition of sarcopenia was based on relative appendicular skeletal muscle (ASM), which was calculated as ASM in kilograms divided by height in squared meters. Sarcopenia was defined as ASM/height^2 being less than two standard deviations (SDs) below the mean of young male and female reference groups (8). This definition was the basis for sarcopenia cutoff points for Chinese population in 2005 (9), which have been widely applied in the studies on Chinese population (10, 11). However, notably, the cutoff points for Chinese (men: 5.72 kg/m^2; women: 4.82 kg/m^2) were calculated using the data derived from only 111 young volunteers (28 male and 83 female). Therefore, the data may not accurately reflect the skeletal muscle mass level of young Chinese adults and could cause bias in the diagnosis of sarcopenia in the Chinese population. Furthermore, the mean ASM/height^2 of young Asian adults has been reported to be approximately 15% lower than their Western counterparts. This would lead to lower cutoff points for sarcopenia and lower prevalence of sarcopenia (9). However, whether the lower cutoff points for Chinese population are reasonable remains unclear.

In the past, other methods have been established to define sarcopenia. In 2002, Janssen et al. proposed a skeletal muscle index (SMI=100 × skeletal muscle mass/ body mass) (12). Subjects whose SMI were within one to two SDs below the mean SMI of young adults (aged 18 to 39 years) were diagnosed as having Class I sarcopenia and those with SMI below two SDs were defined as having Class II sarcopenia. Recently, some researchers have recommended an alternative definition of sarcopenia: the residuals method, which take both height and body fat into consideration (1, 13). The European Working Group on Sarcopenia in Older People (EWGSOP) has summarized these methods and recommends using the presence of both low muscle mass and low muscle function (strength or physical performance) for the diagnosis of sarcopenia (7). However, because these definitions for sarcopenia are based on studies in Western countries, whether the criteria for sarcopenia could be applied in the Asian context, especially when the ethnic difference in body composition is considered, also remains unclear (14–16). Therefore, this study aims to examine whether the current definitions for sarcopenia are suitable for the Chinese population.

Methods

Study Design and Participants

The data of this study were from a national survey on body composition of the Chinese population. The nationally representative cross-sectional survey was conducted in 2006 in four regions in China: Jinan, Guangzhou, Xi'an, and Chengdu. Participants aged 18 or above were randomly recruited from the residents living in the four regions. The sample size recruited in

Received November 16, 2010
Accepted for publication February 7, 2011

each region was nearly 200. Participants were divided into five age groups: (<29 y; 30–39 y; 40–49 y; 50–59 y; 60–69 y). Stratified random sampling was applied in the current study; about 40 participants (approximately 20 men and 20 women) were recruited in each age group in each region. Prior to the body composition and handgrip strength test, participants were required to self-report their medical history through a questionnaire. The participants who were found by doctors to have physical disability or receiving medications that may influence their body composition were excluded from the survey. Consequently, five adults were excluded from the study. Data from 783 adults (354 men and 429 women) aged 18–69 were included in the analysis.

Body Composition

Whole and regional body fat mass and lean mass of the participants were measured by fan beam dual energy x-ray absorptiometry (DEXA; QDR 4500 A, Hologic, Inc., Waltham, MA) following procedures and validation introduced in previous studies (17, 18). ASM was calculated as the sum of skeletal muscle mass in arms and legs. ASM/height^2 was computed as the indicator of relative ASM. SMI was analyzed based on the equation established by Janssen et al. (12).

Handgrip Strength

The grip strength of the dominant hand of each participant was measured using a standard adjustable digital handgrip dynamometer (Beijing Xindong Scientific Instruments Co., LTD, China). Participants were instructed to exert maximal force at standing position with shoulder adducted and neutrally rotated and elbow in full extension. Each participant was allowed to take three test measurements, and the maximum of the three values was applied in the analysis. As suggested by a previous study (19), grip strength in the lowest 20% adjusted for gender and body mass index (BMI) was defined as low handgrip strength.

Body weight and height of participants were measured by trained technicians, and demographic information were collected through a questionnaire. Signed informed consent was obtained from all participants prior to the survey.

Sarcopenia Classification

Three methods were used to identify sarcopenia in this study. For the ASM/height^2 method, sarcopenia was identified as present in participants whose ASM/height^2 were lower than two SDs below the sex-specific mean of Chinese young adults. For SMI method, Class I sarcopenia was established in participants whose SMI were within one to two SDs below the sex-specific mean of young adults. Class II sarcopenia was ascertained in participants whose SMI were lower than two SDs below the sex-specific mean of young adults. The residuals method was based on the regression model recommended by Newman et al. (13). Linear regression equations using height (m) and fat mass (kg) to predict ASM were determined for male and female respectively. The residuals of the regression were applied to identify participants whose ASM were lower or higher than the predicted. The 20th percentile of the distribution of residuals was used as the cutoff points for sarcopenia. Separate models were fit for men (ASM (kg)= -30.239 + 30.105 ×height (m) + 0.141 × fat mass (kg)) and women (ASM (kg)=-15.407 + 17.595× height (m)+ 0.162 × fat mass (kg).

Data Analysis

Descriptive statistics (means and SDs) were used to describe key clinical and demographic characteristics. The relationship between age and ASM/height^2, SMI, total fat mass, and handgrip in men and women were illustrated by scatter plots and fit lines. Based on ASM/height^2, SMI, and residuals methods, the prevalence of sarcopenia in men and women were calculated. Receiver operator characteristic (ROC) curves analysis for the parameters of each muscle mass (ASM/height^2, SMI and residuals) was performed using handgrip weakness for reference. The area under the curve (AUC) and 95% confidence intervals (CI) were determined to examine the relationship between the parameters and handgrip strength.

Results

Descriptive statistics are summarized in Table 1. The mean of ASM/height^2 for young men and women (18–39 y) were 8.0 ± 1.1 kg/m^2 and 6.1 ± 0.9 kg/m^2, respectively. Compared with young adults, BMI, total fat mass, and total body fat (%) were significantly higher in both middle age (40–59 y) and older (60–69 y) Chinese adults. Compared with young adults, older men had significantly lower total lean body mass and ASM. However, total lean body mass and ASM of older women were not significantly lower than those of young adults. Notably, no significantly lower ASM/height^2 was found in older men and women compared with young men and women (Figure 1). In contrast, SMI and handgrip strength in older adults significantly decreased. Moreover, higher total body fat was found in both older men and women compared with their young counterparts.

Based on ASM/height^2, none of older adults could be diagnosed as afflicted with sarcopenia (two SDs below the mean value of young adults). If SMI method was used, the prevalence of Class I (one SD below the mean value of young adults) and Class II (two SDs below the mean value of young adults) sarcopenia were 39.4% and 0% for older men and 25.6% and 17.9% for older women respectively. Furthermore, 33.3% of older men and 25.6% of older women were identified as affected by sarcopenia if the residuals method was used.

ROC curves were used to compare the discriminating power of ASM/height^2, SMI, and residuals in detecting handgrip weakness. The data show that AUCs for SMI were 0.83 and 0.79 in men and women (Figure 2). In contrast, the AUCs for ASM/height^2 and residuals in both men and women were much lower. Compared with ASM/height^2 and residuals methods, SMI showed higher discriminating power in identifying persons with low handgrip strength.

Table 1
General Characteristics of the Study Population

	Men, (mean, SD)				Women, (mean, SD)			
	18–39 y n=179	**40–59 y n=142**	**60–69 y n=33**	**P**	**18–39 y n=188**	**40–59 y n=202**	**60–69 y n=39**	**P**
Age, year	27.0 (6.5) *#	49.0 (5.7) *Δ	64.8 (2.9) #Δ	0.000	27.3 (6.8) *#	49.4 (5.3) *Δ	64.1 (2.6) #Δ	0.000
Height, cm	172.4 (6.3) *#	169.1 (5.8) *	167.3 (5.0) #	0.000	160.0 (6.0) *#	157.6 (5.5) *Δ	154.2 (4.6) #Δ	0.000
Weight, kg	68.4 (13.1)	71.5 (10.4)	69.0 (10.4)	0.058	54.9 (12.5) #	58.1 (10.6)	60.1 (13.5) #	0.006
BMI, kg/m^2	23.0 (4.0) *#	25.0 (3.2) *	24.6 (3.0) #	0.000	21.4 (4.4) *#	23.4 (4.1) *Δ	25.2 (4.9) #Δ	0.000
Total lean body mass, kg	51.7 (7.3) #	51.2 (6.0) Δ	48.5 (5.7) #Δ	0.043	36.4 (5.8)	36.1 (4.5)	35.7 (5.3)	0.685
ASM, kg	23.9 (3.8) #	23.1 (3.0)Δ	21.6 (2.8) #Δ	0.001	15.7 (2.9)	15.3 (2.1)	15.0 (2.4)	0.103
ASM/height^2, kg/m^2	8.0 (1.1)	8.1 (0.8)	7.7 (0.9)	0.166	6.1 (0.9)	6.2 (0.8)	6.3 (0.8)	0.520
SMI	76.6 (7.6) *#	72.0 (5.3) *	70.8 (5.1) #	0.000	67.4 (7.0) *#	62.9 (6.1) *Δ	60.5 (6.1) #Δ	0.000
Total fat mass, kg	14.0 (7.7) *#	17.8 (5.8) *	17.9 (5.6) #	0.000	16.3 (7.8) *#	20.0 (7.0) *Δ	22.6 (8.7) #Δ	0.000
Total percentage body fat, %	19.4 (8.0) *#	24.4 (5.5) *	25.5 (5.3) #	0.000	28.6 (7.4) *#	33.5 (6.4) *Δ	36.5 (6.2) #Δ	0.000
Handgrip strength, kg	47.0 (7.3) #	45.7 (7.5)Δ	40.2 (7.3) #Δ	0.000	27.3 (5.1) #	26.2 (4.9)Δ	23.5 (4.8) #Δ	0.000

Note: BMI: body mass index; ASM: appendicular skeletal muscle mass; SMI: skeletal muscle index; ANOVA and SNK test was applied for the group comparison; *: significant difference between 18–39 y group and 40–59 y group, p<0.05; #: significant difference between 18–39 y group and 60–69 y group, p<0.05; Δ: significant difference between 40–59 y group and 60–69 y group, p<0.05

Figure 1
The relationship between age and ASM/height^2, SMI, total fat mass, and handgrip in men and women

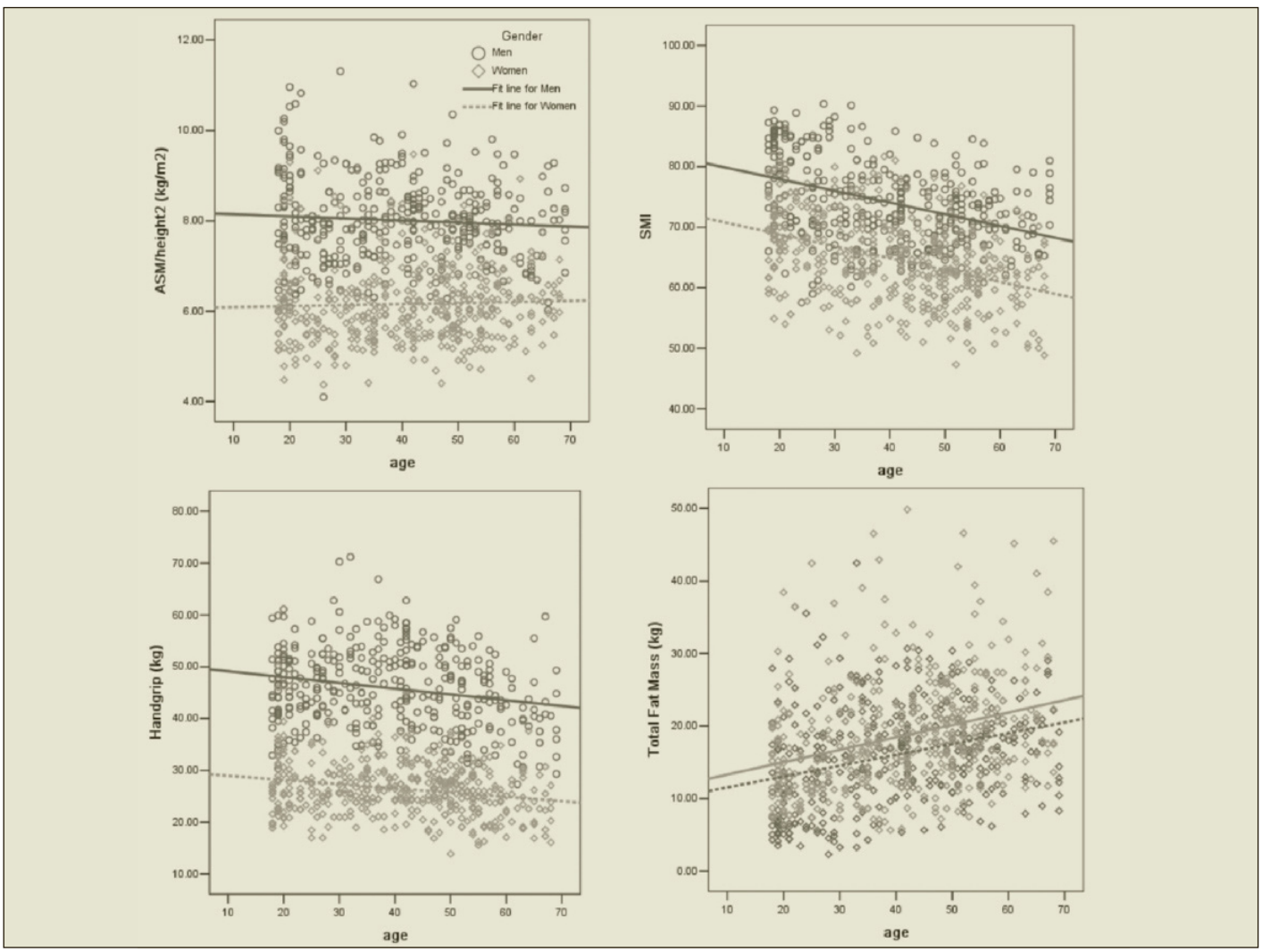
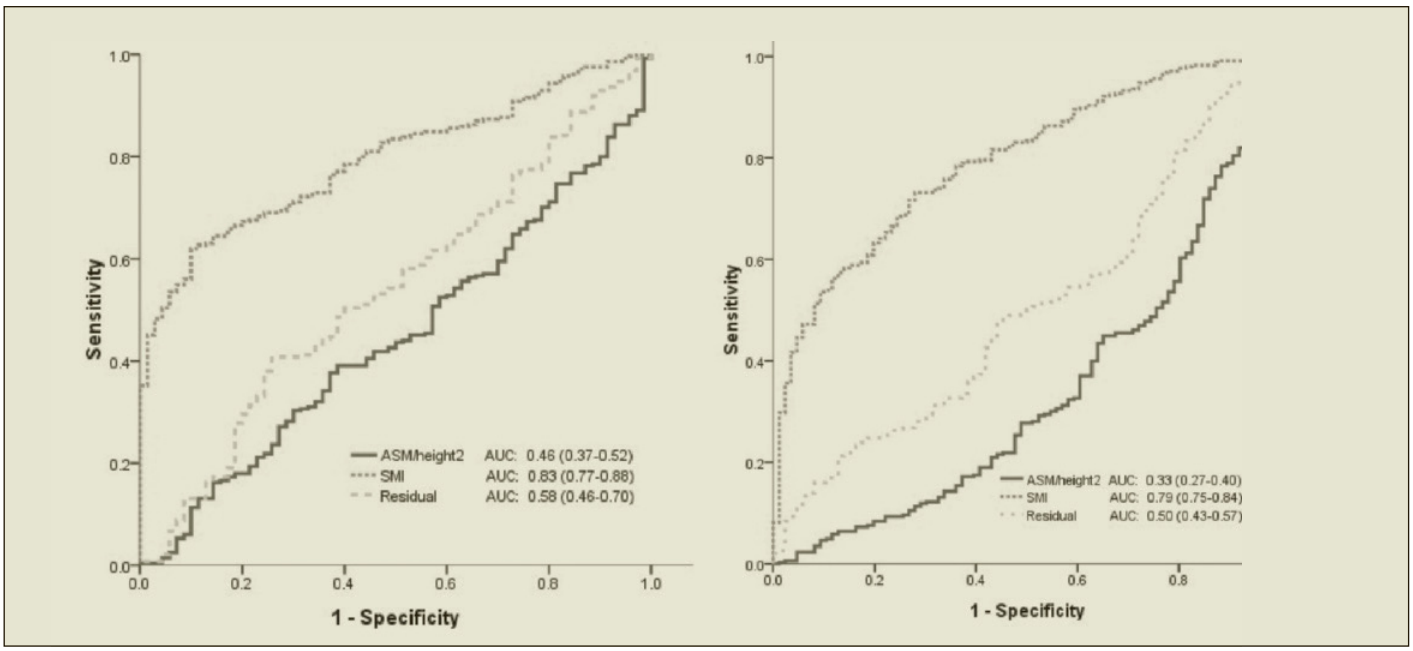


Figure 2
Receiver operator characteristic curve for ASM/height^2, SMI, and residuals to detect weakness in handgrip strength



Discussion

Based on the nationally representative data of Chinese adults, age-associated change of body composition and handgrip strength of Chinese were determined in the current study. Although older Chinese adults were found to have lower SMI and handgrip strength than young adults, no significant decrease in ASM/height^2 in Chinese older adults (<70 years old) was observed. Therefore, if the criterion of two SDs below the mean value of ASM/height^2 in young adults is used, the cutoff points could be too low for the Chinese population. The results of the study show that the cutoff point (ASM/height^2) for Chinese men is 5.85 kg/m^2, which is similar to the cut point in Hong Kong (9). However, the cut point for women (4.23 kg/m^2) is much lower than the value derived from Hong Kong Chinese women (4.82 kg/m^2). The difference could be caused by the different subject recruitment methods. The cutoff points proposed by Lau et al. were based on the data of a small sample size of volunteers. Although the ethnic difference on skeletal muscle mass was reported in previous studies (9, 11), such a significant difference between the cut points between Chinese and American population (American men: 7.26 kg/m^2, American women: 5.45 kg/m^2) was not expected (8). As lower threshold for diagnosing sarcopenia results in lower prevalence of sarcopenia, some researchers have also raised the question whether the two SDs below the mean value is too low for Chinese population (20). The data of this study confirm that none of older adult could be diagnosed as suffering from sarcopenia if the criterion is used. Furthermore, a recent study suggested that sarcopenia cut values achieved by using functional outcomes may better predict physical disability than the two-SD method (11). In addition, handgrip strength is an important index for the diagnosis of sarcopenia (7). However, the results of ROC curves indicate that ASM/height^2 may have low discriminating value in the identification of handgrip weakness. Therefore, the results of the present study indicate that the ASM/height^2 method, which is one of the most widely applied methods in the world, may not be suitable for the Chinese population.

As the influence of body fat mass was not taken into account in ASM/height^2, alternative methods, including SMI and residuals methods, are recommended (7). The data from the study also reveal significant differences in total body fat and total percent body fat among young, middle-age, and older adults groups in both men and women. This indicates that the influence of body fat mass should not be ignored. Furthermore, the results of current study show that SMI method may have better sensitivity and specificity to identify persons with low handgrip strength than ASM/height^2 and residuals methods. However, although sarcopenia is characterized by loss of strength, low handgrip strength should not be equated with sarcopenia. Therefore, concluding that SMI method is a better choice for the Chinese population would be premature. The residuals method was also found to have some limitations (e.g., gender difference problem). At present, no method is considered ideal (1). Sarcopenia should be defined in terms of future physical limitations (11, 21). A working definition of sarcopenia that considers both low muscle mass and low muscle function was recommended by EWGSOP (5). Additional studies are still needed for the diagnosis of sarcopenia.

Several limitations in the current study should be addressed. Because of the difficulties in the recruitment of participants over age 70 in this study, none of partcipants over 70 were

included in the current study, which is a major limitation. Other limitations include small sample size of older adults, lack of data on physical performance, and cross-sectional study design. However, the strengths of the current study include the nationally representative data and random sampling method. In summary, the data suggest that ASM/height^2 method (two SDs below mean value of young adults) may not be appropriate for the Chinese population. Although SMI shows higher discriminating power in the identification of persons with low handgrip than ASM/height^2 and residuals methods, concluding that the SMI method is a better choice is premature. Prospective studies are needed to achieve the exact definition of sarcopenia in the context of the Chinese population.

Financial disclosure: None of the authors had any financial interest or support for this paper.

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