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INCIDENCE, RISK FACTORS, AND THE PROTECTIVE EFFECT OF HIGH BODY MASS INDEX AGAINST SARCOPENIA IN SUBURB-DWELLING ELDERLY CHINESE POPULATIONS

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Abstract: *Background:* Few studies have explored the risk factors of sarcopenia in certain cohorts. The objective of this study was to examine the incidence of sarcopenia and associated factors over a 1-year period in an elderly Chinese suburban population. *Methods:* This study was conducted on 356 Chinese suburb-dwelling participants aged ≥60 years, for whom detailed information regarding sociodemographics, behavioral characteristics, and medical conditions had been documented. Sarcopenia was defined according to the Asian Working Group for Sarcopenia (AWGS) criteria. Sarcopenia incidence was documented after one year of follow-up, and correlated with several possible factors. *Results:* At baseline, 64 (9.7%) of the initial 657 participants had sarcopenia. The prevalence of sarcopenia was 10.4% after one year. Between baseline and 1-year follow-up, 13 of the participants without sarcopenia at baseline had developed sarcopenia. After multivariate adjustments, it was found that the incidence of sarcopenia increased with age and high body mass index (BMI) is associated with less incidence of sarcopenia. Incidence was also higher among women. *Conclusions:* We found sarcopenia incidence increased with age, and women were more likely to have sarcopenia. A higher BMI is also associated with a lower incidence of sarcopenia. Maintaining a healthy weight could be beneficial in the prevention of sarcopenia.

Key words: AWGS, body mass index, Chinese, sarcopenia, suburb-dwelling.

Introduction

Sarcopenia, a syndrome characterized by progressive and generalized loss of skeletal muscle mass, muscle strength, and physical performance (1), is a common condition associated with functional decline, falls, disability, morbidity, and mortality among the elderly population (2). Because the symptoms and side effects of this disease can be severe, it is important to work toward preventing sarcopenia and to diagnose it promptly.

Understanding the causes, prevention and treatment of sarcopenia is increasingly important in geriatric medicine. Although much research effort has been directed toward development of a universal definition of sarcopenia and determining its prevalence, associated factors, and consequences, there have been few studies aimed at examining the incidence of sarcopenia and their risk factors (3). Furthermore, the identification of risk factors could facilitate the implementation of preventive efforts to reduce incidence. However, data on the risk factors of sarcopenia in the Chinese population is scarce, especially using the Asian Working Group for Sarcopenia (AWGS) definition (4). The AWGS, taking a similar approach to the European Working Group on Sarcopenia in Older People (EWGSOP) developed diagnostic criteria for sarcopenia based on three parameters: muscle mass, muscle strength and physical performance (5). The group has added some Asian perspectives with respect to sarcopenia diagnosis and research, and proposed a diagnostic algorithm based on currently available evidence in Asia (6).

Previous studies based on cross-sectional data have reported age, low body mass index (BMI), low weight, and minimal physical activity as associated factors of sarcopenia (7-10). Our previous cross-sectional study (11), using the AWGS definition, examined the prevalence of sarcopenia and associated factors in an elderly suburban population in China. We found that high BMI is inversely associated with the likelihood of being sarcopenic. Several other studies found that the incidence of diabetes and peptic ulcers increase the prevalence of sarcopenia. Drinking habits were also found to be associated with the incidence of sarcopenia. However, our previous study and other research about the prevalence and risk factors of sarcopenia in the Chinese population so far have been based on cross-sectional data, which could not determine any causal. Recent cohort studies have shown the following factors to be associated with sarcopenia: older age, female sex, lower body mass index, presence of chronic obstructive pulmonary disease, stroke, cystatin C, kidney dysfunction, higher physical activity levels, and impaired abilities to perform activities of daily living (3, 12). Differences in population, ethnicity, genetic background, and living environment have effects on the development of sarcopenia; however, the precise risk factors associated with sarcopenia are not well defined. Thus, longitudinal studies are necessary to determine the true causes and influences on sarcopenia incidence.

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Therefore, the aim of the present study was to address the question of the incidence of sarcopenia over a 1-year period using the AWGS criteria, and to examine the risk factors predisposing individuals to the onset of sarcopenia in China, specifically in suburb-dwelling elderly populations. This study is particularly significant since more than 70% of elderly individuals live in suburban areas in China, as of 2012 (13).

Methods

Study participants

Our study population included residents from Chadian of Tianjin, China. 661 of older individuals (age≥60) in these area joined the national free physical examination program from May 2013; all 661 subjects were invited to participate in a comprehensive geriatric assessment. Participants with the following conditions were excluded from the study: (i) unable to communicate with interviewers or to grant informed consent; (ii) unable to perform the handgrip strength test or the 4-m walking test; and (iii) unable to stand for measurement of body composition, weight and height. The final study population comprised 657 subjects after 4 were excluded. The cohort was invited to attend repeat questionnaire interviews and physical measurements after 1 year. Two hundred and ninety-three participants were excluded because they were lost to follow-up. All nonparticipants or their family members have received telephone follow-up to explain the reasons of missing follow-up examination and health condition over the past year. As a result, all individuals were keep health except 5 died and 3 bedridden persons. Thus, five participants died, leaving 359 participants alive at the first follow-up. Three participants were ill in bed and could not attend our test. Prevalence and risk factors of sarcopenia was therefore assessed in 356 persons, 136 men and 220 women. All participants provided informed consent prior to participation. The study was approved by the Ethics Committee of Tianjin Medical University.

Covariates

Data regarding sociodemographic, behavioral characteristics, and medical conditions were obtained as previously (via face-to-face questions) (14). Sociodemographic variables, including age, gender, marital status, educational level, and occupation, were assessed. Assessed behavioral characteristics included smoking and drinking habits, and history of falls. We next obtained and processed variables of physical activity and depressive symptoms. Physical activity was assessed using the short form of the International Physical Activity Questionnaire (IPAQ) (15). Depressive symptoms were assessed using the Geriatric Depression Scale (16). Nutritional assessment was based on the Mini Nutritional Assessment– Short Form (MNA-SF), a validated screening tool used in geriatric health care. It consists of 6 items (food intake, weight loss, mobility, stress, neuropsychological problems and BMI) with a maximum score of 14, resulting in three categories: malnourished (score 0–7), at risk of malnutrition (score 8–11) and normal nutritional status (score 12–14) (17). Medical history, including diabetes, hypertension, hyperlipidemia, heart disease, peptic ulcer, pulmonary disease, stroke, kidney disease, hepatic disease, and osteoarthritis, was also recorded. Details of survey methods have been described in our previous cross-sectional study (11).

Assessment of Sarcopenia

Sarcopenia was defined according to the AWGS criteria (4), in which a person who has low muscle mass, low muscle strength and/or low physical performance was identified as having sarcopenia. Low muscle mass was classified as relative skeletal muscle mass index (ASM/ht^2) less than 7.0kg/m^2 and 5.7kg/m^2 in men and women, respectively; low muscle strength was defined as grip strength <26kg or <18kg for males and females, respectively; low physical performance was defined as walking speed <0.8m/s for both males and females. Details of measurement methods have been described in our previous cross-sectional study (11).

Statistical Analysis

Characteristics of individuals at baseline were reported as medians ± 25-75th percentiles for IPAQ; all other continuous variables were presented as mean and standard deviation; classification variables were reported as percentages. Differences in the characteristics according to sarcopenia status were analyzed using t-tests, $\chi 2$ tests, and Kruskal–Wallis rank tests. Risk factors for sarcopenia incidence at the follow-up year were first analyzed individually using logistic regressions. Subsequently, multiple logistic regression models were constructed by stepwise and backward elimination algorithms. In these models, age, sex, BMI, MNA-SF, marital status, and living conditions were included. All statistical analyses were performed using SPSS version 19.0, and P-values less than 0.05 were considered statistically significant.

Results

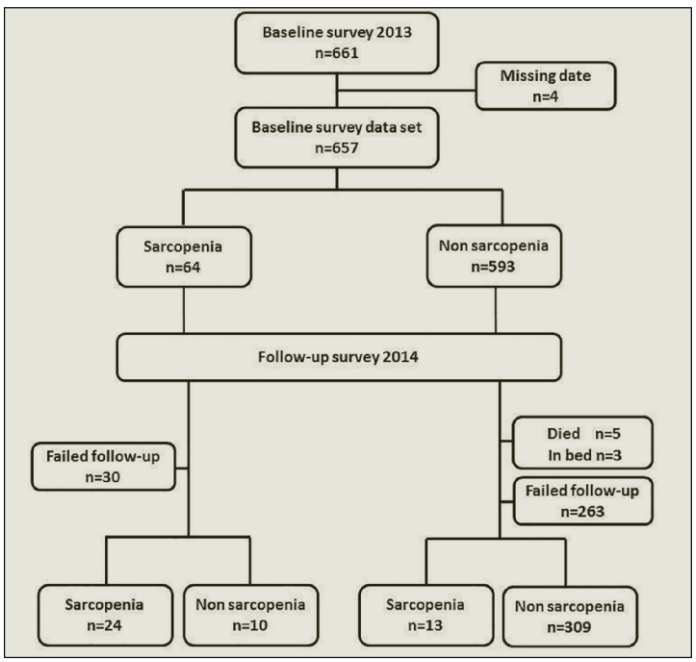
Baseline characteristics

Figure 1 shows the participants over the follow-up period. Of the 657 participants at baseline, 64 (9.7%) had sarcopenia, 21 (3.2%) of whom were men and 43 (6.5%) of whom were women. The prevalence of sarcopenia was 10.4% at the 1-year follow up, representing an increase of 2.5% men and 7.9% women. Between baseline and 1-year follow-up, 13 of the participants without sarcopenia at baseline had developed sarcopenia.

Table 1 presents the characteristics of these participants by sarcopenia status. In the group with no sarcopenia at baseline, subjects with new-onset sarcopenia had a statistically significant lower ASM/Ht^2, handgrip strength, and walking speed compared with subjects without sarcopenia (P<0.05). Compared to subjects without sarcopenia, those with new-onset sarcopenia were more likely to be older, female, widowed,

living alone, and of a lower BMI (P<0.05).

Figure 1



Risk factors of incident sarcopenia

Factors associated with sarcopenia incidence from baseline to 1-year follow-up are shown in Table 2. After adjustments for potential confounders (age, sex, BMI, MNA-SF, marital status, and living conditions), the following factors were associated with sarcopenia incidence from baseline to 1-year follow-up, respectively: age (adjusted OR 1.23; 95% CI 1.10–1.39), female sex (adjusted OR 21.07; 95% CI 2.35–188.39), and BMI (adjusted OR 0.81, 95% CI 0.69–0.96).

Discussion

At baseline the overall prevalence of sarcopenia using the AWGS definition was 9.7%. The prevalence of sarcopenia increased to 10.4% after 1-year follow-up. The following factors were directly associated with sarcopenia from baseline to the 1-year follow-up, after adjusting for potential cofounders: age, female sex, and BMI. Among those factors, high BMI was found to be protective against sarcopenia incidence.

The annual incidence of sarcopenia in the 1-year follow-up was 4.0% over the age of 60 years and more. Incidence of sarcopenia increased steeply with age: incidences were 3.9%, 11.9%, and 16.7% of women aged 60-69, 70-79, and ≥80, respectively. In men, incidences (corresponding to the same age groups) were 0.0%, 0.0%, and 10.0%. The association of sarcopenia with age in this study is consistent with earlier findings (10, 18, 19). Those studies found that loss of muscle mass and function occurs with age (18), and annual loss of muscle mass has been reported as 1-2% at the age of 50 years onwards (20). In our study, the prevalence of sarcopenia was higher in women than in men over the age of 60 years and more; in another study, sarcopenia appeared to be related to gender, with males more commonly affected than females (9), while another study showed a numerically higher prevalence of sarcopenia and severe sarcopenia in women than in men (21). However, most studies to date have reported no significant association with sarcopenia prevalence between men and women (22,23). Our results suggest being older (OR=1.23, 95% CI=1.10-1.39) and female (OR=21.07, 95% CI=2.35-188.39) may increase the risk of developing sarcopenia. Based on our findings, we should give more attention to women with sarcopenia, as women live longer and have higher rates of disability (24), thus posing a greater public health problem.

Our finding is in line with Yu et al. (12) and Kim et al. (3), who found high body mass index is protective against sarcopenia incidence. Although obesity is believed to be a risk factor for many adverse outcomes, being slightly overweight might be beneficial in elderly populations. Indeed, in the present study, sarcopenic participants were significantly thinner (measured by BMI) than non-sarcopenic participants of both groups. It has been pointed out that fat mass can have several age-related effects on lean mass, and individuals with higher fat mass might have a higher protein intake, which is a protective factor against sarcopenia (25). Our study supported this hypothesis, showing an odds ratio of 0.81 for BMI. Given this, we postulated that higher BMI might serve as a protective buffer by countering losses in muscle performance in the elderly.

Strengths and Limitations of the Study

This study has a number of strengths. First, this study is one of the first studies using AWGS criteria to identify the risk factors of sarcopenia in Asia. Secondly, the study was also the first one to examine a uniquely-defined group of suburban older men and women living in a discrete geographical area. Our participants were recruited from a suburban area, and were leading a more physically active lifestyle, which might different from subjects in other geographical areas.

Despite extensive efforts to curb study limitations, some did exist. First, all participants in the present study were relatively healthy, as we did not include participants who were unable to participate in the free annual national physical examination (e.g. those bedridden or with serious disease). Due to this, our results might in fact be an underestimate of the prevalence of sarcopenia and its associated health impact. Second, we admit that the follow-up period was short and the number of new sarcopenic cases during follow up was small, which might have decreased the power to evaluate the risk factors. However, we analyzed baseline data of follow-up group compared with individuals of losing follow-up, and found that there is no significant difference in prevalence of sarcopenia, as well as other variables (age, sex, BMI, marital status, educational level, occupation, medical history and so on). Therefore, at some

Table 1
Baseline characteristics of study participants according to the presence of sarcopenia

		No sarcopenia at baseline	
Characteristic	**No sarcopenia (n=309)**	**Sarcopenia* (n=13)**	**p_value**
Age (y)	67.44±5.33	72.08±5.56	0.002
Sex			0.019
Male (%)	124(40.1)	1(7.7)	
Female (%)	185(59.9)	12(92.3)	
BMI (kg/m^2)	25.99±3.39	23.37±3.93	0.007
ASM/Ht^2 (kg/m^2)	7.06±1.05	5.81±0.86	<0.001
Grip strength (kg)	26.73±8.19	19.73±4.47	0.002
Walking speed (m/s)	1.02±0.19	0.91±0.22	0.041
MNA-SF	13.21±1.22	13.15±1.52	0.300
IPAQ (MET)	(1069,2013)	(1131,1371)	0.253
Widowed (%)	45(14.6)	6(46.2)	0.002
Living alone (%)	29(9.4)	5(38.5)	0.001
Illiterate (%)	65(21.0)	4(30.8)	0.402
Farming (%)	264(85.4)	12(92.3)	0.488
Fall history (%)	62(20.1)	4(30.8)	0.349
Depression (GDS>=11) (%)	31(10.0)	2(15.4)	0.533
Drinking (%)	73(23.6)	4(30.8)	0.554
Smoking (%)	93(30.1)	3(23.1)	0.588
Diabetes (%)	38(12.3)	2(15.4)	0.741
Hypertension (%)	145(46.9)	6(46.2)	0.956
Hyperlipidemia (%)	94(30.4)	2(15.4)	0.246
Heart disease (%)	77(24.9)	2(15.4)	0.434
Peptic ulcer (%)	16(5.2)	0(0.0)	0.400
Pulmonary disease (%)	7(2.3)	1(7.7)	0.218
Stroke (%)	21(6.8)	1(7.7)	0.900
Kidney disease (%)	2(0.6)	0(0.0)	0.771
Hepatic disease (%)	12(3.9)	0(0.0)	0.469
Osteoarthritis (%)	79(25.6)	3(23.1)	0.840

BMI, body mass index; ASM, appendicular skeletal muscle mass; Ht, height; MNA-SF, Mini Nutritional Assessment-Short Form; IPAQ, international physical activity questionnaire; GDS, geriatric depression scale; * Sarcopenia, subjects with onset sarcopenia. The one without sarcopenia at baseline, had developed sarcopenia from the follow-up year

level, our follow-up study can reflect the status of sarcopenia in the locality. And yet, the statistical differences between the participants with and without sarcopenia were still observed, implying that statistical power should not be a serious problem. Even so, we will enlarge sample sizes and extend the years to follow-up to increase the power to evaluate the risk factors in future research.

In summary, we examined the prevalence of sarcopenia and determined risk factors for sarcopenia in an elderly suburban population in Tianjin, China, using the AWGS definition. We find sarcopenia incidence increased with age. There was also a higher incidence of sarcopenia among women. A higher BMI is protective against sarcopenia incidence. Thus, based on our findings and those of previous studies, clinical practitioners should potentially suggest treatment options to improve sarcopenia alongside increasing BMI, especially in the older adults. Further studies with a longer duration of follow-up and additional samples are needed to confirm these associations, and further research should examine other lifestyle behaviors that might contribute to sarcopenia.

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Table 2
Multiple logistics regression on incidence of sarcopenia during baseline to 1-year

Variable	Univariate Odds Ratio(95% CI)	P§	Adjusted Model Odds Ratio (95% CI)	P§
Age	1.15(1.05-1.26)	0.004	1.23(1.10-1.39)	<0.001
Sex				
Male	Referent		Referent	
Female	8.03(1.03-62.64)	0.047	21.07(2.35-188.39)	0.006
BMI	0.80(0.70-0.95)	0.009	0.81(0.69-0.96)	0.012
MNA-SF	0.97(0.63-1.49)	0.877		
Widowed				
No	Referent			
Yes	5.21(1.62-15.65)	0.005		
Living alone				
No	Referent			
Yes	6.03(1.85-19.66)	0.003		

§ Statistically significant P values (P<0.05) for backward stepwise multiple logistic regressions.

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Conflict of interest: The authors declare no conflict of interest.

Ethical Standards: The experiments comply with the current laws of the country in which they were performed.

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