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Prevalence of and Risk Factors for Sarcopenia in Elderly Chinese Men and Women

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Background. Several studies have documented the substantial health and economic burdens associated with sarcopenia among the elderly, but there has been no systematic study among Asians. A cross-sectional survey of elderly community-dwelling Chinese volunteers (262 men and 265 women), aged 70 years and older, was undertaken in Hong Kong. The purposes of this study were to evaluate the prevalence of and risk factors for sarcopenia in elderly Chinese, and to compare these observations with those in white persons.

Methods. Muscle mass was estimated by dual-energy X-ray absorptiometry. In this study, sarcopenia was defined as a total adjusted skeletal muscle mass two standard deviations or more below the normal mean for young Asian men and women in this study. The relationship between risk factors (alcohol consumption, cigarette smoking, regular exercise, body mass index, medical conditions) and sarcopenia was studied by multiple logistic regression.

Results. The prevalence of sarcopenia was 12.3% in Chinese men and 7.6% in Chinese women aged 70 years and older, which was slightly lower than figures observed in white persons. Being underweight was a significant risk factor in both men (odds ratio, 39.1; 95% confidence interval, 11.3 to 134.6) and women (odds ratio, 9.7; 95% confidence interval, 2.8 to 33.8). No other risk factors were found in Chinese men or women.

Conclusions. Sarcopenia exists among elderly Chinese men and women, albeit at a lower rate than in white persons. This may be due to the lower muscle mass among young men and women or to an attenuated rate of loss in muscle mass with aging in the Chinese elderly. Being underweight is a major risk factor for sarcopenia in both sexes.

SARCOPENIA is defined as a decrease in muscle mass in aging men and women (1), and its health consequences are being increasingly recognized (1,2). The epidemiologic nature of sarcopenia has been studied in white (3,4) and Hispanic (3) persons. In these studies, sarcopenia was defined statistically as a reduction in muscle mass of two standard deviations or more below the normal means for young persons. Using such a definition, the prevalence of sarcopenia was found to be fairly substantial in both men and women, with the prevalence increasing rapidly with aging.

The health consequences of sarcopenia are also increasingly being recognized. For instance, Baumgartner and colleagues (3) found that sarcopenia was associated with self-reported physical disability in both men and women, independent of ethnicity, age, morbidity, obesity, income, or health behavior.

As in other parts of the world, the Asian population is aging rapidly. For instance, in Hong Kong, the average life expectancy is 77 years for men and 82 years for women (5). Nevertheless, the phenomenon of sarcopenia has not been studied in Asians. Such knowledge is essential for the development of public health programs for elderly persons, and we report here the findings of the first study conducted in Asians. Our objectives were to describe the prevalence of and risk factors for sarcopenia in Chinese persons living in Hong Kong and to compare these with published data from white persons.

Methods

Study Participants

We recruited young, healthy Chinese volunteers aged 20 to 50 years from the general community in Hong Kong to establish normal ranges for lean body mass, appendicular skeletal muscle mass (ASM), and total skeletal muscle mass (TSM, defined below).

Meanwhile, we collected lean body mass and muscle mass data in elderly Chinese men and women in Hong Kong. We displayed posters and recruited volunteers from community and social centers and general practice clinics in the District of Shatin, Hong Kong. We excluded no elderly persons for health reasons.

We used a standardized, structured interview questionnaire to obtain information on cigarette smoking, alcohol consumption, and frequency of load-bearing exercise. We determined the frequency with which five forms of load-bearing exercise were performed. We asked the participants whether they had been diagnosed with any medical conditions necessitating long-term treatment. We obtained additional information on oral contraceptive use, age of menarche, menopausal status, and age of menopause in women. We measured height and weight with participants wearing light indoor clothing but not shoes using a standing scale with a height attachment.

Muscle Mass Determinations

We measured body composition using dual-energy X-ray absorptiometry using a Hologic QDR 2000 densitometer

Table 1. Normal Values (Mean ± *SD*) for Lean Body Mass and Skeletal Muscle Mass Parameters Among Young Chinese Men and Women

Variable	Men ($N = 28$)	Women ($N = 83$)
Total lean body mass (LBM), kg	43.5 ± 4.62	37.9 ± 4.58
LBM/height^2, kg/m^2	16.0 ± 1.59	15.0 ± 1.56
Appendicular skeletal muscle mass (ASM), kg	20.3 ± 2.23	16.2 ± 2.24
ASM/height^2, kg/m^2	7.4 ± 0.84	6.4 ± 0.79
Total skeletal muscle mass (TSM), kg	27.0 ± 2.97	21.5 ± 2.97
TSM/height^2, kg/m^2	9.9 ± 1.12	8.5 ± 1.05

Note: Total skeletal muscle mass = 1.33 × ASM.

(Hologic, Waltham, MA). The ASM (measured in kilograms) was determined as the sum of the skeletal muscle mass for the arms and legs, deduced from the manufacturer's default definitions, as described by Heymsfield and colleagues (6). In addition, we estimated TSM (measured in kilograms) by multiplying the ASM by 1.33 in accordance with the assumption that ASM represents 75% of the TSM (7).

Because muscle mass is strongly correlated with body size (3), we adjusted for height in the analysis. Relative ASM was calculated as ASM in kilograms divided by height in square meters, using the analogy of body mass index (BMI) (3). As proposed by Baumgartner and colleagues (3), we defined sarcopenia as muscle mass levels more than two standard deviations below the sex-specific normal mean for young persons.

Sex-specific normative data were taken from 83 premenopausal women and 28 men younger than 40 years (Table 1). Quantile-quantile plots verified that each of the muscle mass parameters among both the young volunteers and elderly participants were distributed in an approximately normal pattern.

Statistical Analyses

We determined the age- and sex-specific prevalence (%) of sarcopenia using the different indices of muscle mass. We used analysis of covariance to compare the differences between elderly Chinese men and women in terms of age, weight, BMI, lean body mass, fat mass, body fat, percentage, ASM, ASM/height^2, TSM, and TSM/height^2, after adjusting for height. We assessed the likelihood that sarcopenia was associated with alcohol consumption, cigarette smoking, regular exercise, BMI, and various medical conditions using multiple logistic regression analysis. We considered each of the risk factors separately, with adjustment for age in all the analyses.

Table 2. Characteristics of Elderly Hong Kong Chinese Subjects in the Sarcopenia Prevalence Study

Characteristic	Men ($N = 262$) Mean ± *SD*	Women ($N = 265$) Mean ± *SD*	*p* Value*
Age, y	73.8 ± 2.8	76.9 ± 3.7	<.001
Height, m	1.61 ± 0.06	1.47 ± 0.06	<.001
Weight, kg	58.3 ± 9.5	51.1 ± 9.8	.06
Body mass index, kg/m^2	22.5 ± 9.5	23.5 ± 3.9	.05
Lean body mass, kg	38.2 ± 4.6	28.1 ± 3.5	<.001
Fat mass, kg	13.8 ± 5.8	17.6 ± 7.1	<.001
Body fat, %	24.2 ± 6.8	34.9 ± 8.5	<.001
Appendicular skeletal muscle mass (ASM), kg	17.4 ± 2.4	12.4 ± 1.7	<.001
ASM/height^2, kg/m^2	6.7 ± 0.8	5.7 ± 0.6	<.001
Total skeletal muscle mass (TSM), kg	23.1 ± 3.15	16.5 ± 2.22	<.001
TSM/height^2, kg/m^2	8.9 ± 1.08	7.6 ± 0.85	<.001

Note: *By analysis of covariance, and adjusting for height.

Table 3. Prevalence (%) of Sarcopenia as Defined by Various Measures Among Elderly Hong Kong Chinese Men and Women*

Age Group	*n*	Lean Body Mass	ASM	ASM/Height^2	Total Skeletal Muscle Mass
Men					
70–74	157	15.9	19.1	10.2	19.1
75–79	104	27.9	29.8	15.4	29.8
Subtotal	261	20.7	23.4	12.3	23.4
Women					
70–74	69	59.4	34.8	10.1	34.8
75–79	130	62.3	34.6	6.2	34.6
≥80	65	58.5	43.1	6.2	43.1
Subtotal	264	61.0	36.7	7.2	36.7

Note: *Sarcopenia is defined as muscle mass more than 2 *SD* below the sex-specific young normal mean. ASM = appendicular skeletal muscle.

Results

Table 1 shows normal values for lean body mass, ASM, and TSM, and their height-adjusted values based on findings from 28 young men and 87 young women from Hong Kong. The relative TSM of Hong Kong Chinese (TSM/height^2) was 17% lower among young Chinese men compared with white men (4), but the relative TSM of young Chinese women was similar to that of white women.

Table 2 lists the characteristics of the elderly participants. As expected, the men were taller and had greater lean body mass and less fat mass than did the women. With adjustments for height, their BMI values were marginally less than those for women ($p = .05$ by analysis of covariance). However, the relative ASM and relative TSM were still significantly greater in men ($p < .001$ by analysis of covariance).

Table 3 lists the estimated prevalence of sarcopenia in Chinese men and women, as assessed by the different measures. When we used relative TSM to define sarcopenia, the prevalence was similar in Chinese men and Chinese women who were 70 to 74 years old. However, although the prevalence of sarcopenia increased from 10% in men aged 70 to 74 years to 15% in men aged 75 to 79 years, it decreased from 10% in women aged 70 to 74 years to 6% in women who were 75 years or older.

Table 4 shows the prevalence of sarcopenia in Chinese men and women compared with data from white men and women previously published in the literature. Because of differences in definitions and compilation, figures in Chinese men and women could be more easily compared with data obtained by Melton and colleagues (4). The prevalence of sarcopenia in Chinese men and women younger than 80 years is lower than that in white men. However, the prevalence of sarcopenia in Chinese women older than 80 years was comparable to that in white women (4).

Table 4. Prevalence (%) of Sarcopenia in Elderly Hong Kong Chinese Men and Women, as Compared to Caucasians

Age Group	Chinese*	Caucasians†	Caucasians‡	Caucasians‖	Hispanics‖
Men					
70–74 y	10.2	}16	}7	19.8	18.3
75–79 y	15.4			26.7	36.4
≥80 y	NA	34	7	52.6	57.6
Women					
70–74 y	10.1	}11.8	}11	33.3	35.1
75–79 y	6.2			35.9	35.3
≥80 y	6.2	4.1	11	43.2	60.0

Notes: *Sarcopenia in Chinese is defined as relative total skeletal muscle mass (kg/m^2) more than 2 *SD* below sex-specific young normal mean.

†Sarcopenia is defined as relative total skeletal muscle mass (kg/m^2) more than 2 *SD* below young normal mean (4).

‡Sarcopenia is defined as a total skeletal muscle mass (kg) more than 2 *SD* below young normal mean, where muscle mass was determined using bioelectrical impedance analysis (6).

‖Sarcopenia is defined as relative total appendicular muscle mass (kg/m^2) more than 2 *SD* below young normal mean (3).

Conversely, the prevalence of sarcopenia in Chinese men was higher than that observed in white men by Janssen and colleagues (8), but values for women were slightly lower.

Table 5 shows the relationship between sarcopenia and various lifestyle and medical factors. In both men and women, being underweight was associated with a significantly increased risk for sarcopenia (in men: odds ratio, 39.1; 95% confidence interval, 11.3 to 134.6; in women: odds ratio, 9.7; 95% confidence interval, 2.8 to 33.8). However, alcohol consumption, cigarette smoking, exercise, and medical disorders were not associated with sarcopenia. We did find, however, a suggestive effect of smoking on sarcopenia in women, but this effect was not statistically significant (odds ratio, 2.4; 95% confidence interval, 0.8 to 6.9).

Discussion

We report here the first investigation of sarcopenia among Asian men and women. The prevalence of sarcopenia in men and women was significantly lower in Asian than in white persons. However, for women who were 80 years or older, the prevalence of sarcopenia was comparable to that in white persons. A low BMI was the only risk factor found to be significant for sarcopenia in this study.

The limitations of the study must be considered before we can make inferences from the results. First, because this was a cross-sectional study, we could not determine risk factors for sarcopenia prospectively. Second, we used volunteers to establish the normal range for young persons and to study the prevalence of sarcopenia in the elderly. Young volunteers may be in better health than the general population, so they may have a larger total muscle mass. This may result in higher normal range values for total skeletal mass, so that sarcopenia may be diagnosed in more of the elderly participants. Conversely, if the elderly persons who volunteered for the study were selectively healthy, the prevalence of sarcopenia reported here may not be applicable to frailer elderly persons in poorer health.

We defined sarcopenia as a relative total skeletal mass of more than two standard deviations below the respective normal means for young persons. Other investigators have adopted similar definitions, making interethnic comparisons feasible (3,4,8). We found the prevalence of sarcopenia to be lower in Asians compared with published results in white

Table 5. Association of Sarcopenia With Various Lifestyle Factors Among Elderly Hong Kong Chinese Men and Women*

	Men			Women		
Lifestyle Factors	% in Controls (N = 141)	% in Sarcopenia Cases (N = 32)	Odds Ratio (95% CI)	% in Controls (N = 153)	% in Sarcopenia Cases (N = 19)	Odds Ratio (95% CI)
Alcohol consumption						
Never	46.8	53.1	1.0	98.6	100	1.0
<7 Days/wk	27.0	25.0	0.7 (0.3–1.8)	0.7	0	NA
Daily	26.2	21.9	0.7 (0.3–1.9)	0.7	0	NA
Cigarette smoking						
Never	19.9	15.6	1.0	82.9	68.4	1.0
Current or ex-smoker	80.1	84.4	1.2 (0.4–3.4)	17.1	31.6	2.4 (0.8–6.9)
Regular exercise						
Yes	28.4	37.5	1.0	61.2	57.9	1.0
No	71.6	62.5	0.6 (0.3–1.4)	38.8	42.1	1.1 (0.4–3.0)
Body mass index						
≥18.5	97.2	46.9	1.0	91.4	68.4	1.0
<18.5	2.8	53.1	39.1 (11.3–134.6)	5.9	31.6	9.7 (2.8–33.8)
Medical conditions						
Diabetes mellitus	12.1	9.4	0.8 (0.2–3.1)	10.5	5.3	0.5 (0.1–3.6)
Thyroid disease	0	0	NA	2.0	0	0
Cancer	0	0	NA	7.2	5.3	0.6 (0.1–4.9)
Gastrectomy	17.9	12.5	0.7 (0.2–2.3)	3.9	5.3	1.2 (0.1–10.9)
Liver disease	2.1	3.1	1.6 (0.2–16.4)	0	0	NA
Rheumatoid arthritis	7.1	6.3	0.8 (0.2–4.0)	12.5	10.5	0.6 (0.1–3.1)
Chronic obstructive airway disease	9.2	12.5	1.7 (0.5–5.9)	1.3	0	NA

Note: *Sarcopenia in Chinese is defined as relative total skeletal muscle mass (kg/m^2) more than 2 *SD* below sex-specific young normal mean. NA = not applicable.

and Hispanic populations (3,4,8). The only exception was in our older Chinese women, in whom the prevalence of sarcopenia was similar to that observed in white women. The reasons for the lower prevalence of sarcopenia in Asians should be evaluated from the perspective of specific diagnoses and causes of sarcopenia. Because sarcopenia in the elderly is defined according to normal values for young persons, lower muscle mass in young Asians will result in a lower threshold for diagnosing sarcopenia, and thus fewer patients. We have indeed found this to be the case. The mean ASM in young Asian men and women was approximately 15% lower than that in white persons, after adjustment for height. This would result in a lower absolute normal value for diagnosing sarcopenia, so that the condition would be diagnosed in fewer persons.

Sarcopenia may also be rarer in Asians as a result of differences in risk factors, as compared with white persons. Many factors could contribute to sarcopenia (9,10). As described by Janssen and colleagues (8), these could include a loss of α-motor neurons (11), lower levels of steroid hormones (12,13), a reduction in dietary protein (14), and a decreased level of physical activity (15). We do not know whether Asian men and women have slower loss of α-motor neurons or a slower decrease of steroid hormone levels with aging. However, the diet and physical activity of Asian persons could have protected them against sarcopenia. In a previous study by Woo and colleagues (16), the mean protein intake of elderly Chinese persons was 1.2 g/kg body weight, which was well above the World Health Organization recommendations of 0.8 g/kg. Furthermore, elderly Chinese persons tend to walk much more than do their Western counterparts. In this study, we found that participants spent an average of 17.5 hours walking outdoors each week. The adequacy of protein intake, with frequent regular walking, could have protected the Asian elderly against sarcopenia.

The design of our investigation was not ideal for studying the risk factors for sarcopenia. The study was cross-sectional in nature and risk factors were documented only briefly. For instance, exercise was documented only in terms of the frequency of performing selected load-bearing activities, and detailed dietary data were not available. Among the many risk factors, a low BMI was the only one associated with sarcopenia in both men and women. We found no significant association between sarcopenia and the following risk factors: cigarette smoking, alcohol consumption, or medical conditions. However, because of the design issues noted already, the results regarding risk factors are not conclusive.

Despite the apparent low prevalence of sarcopenia in Asia, the burden due to the problem will certainly increase as the Asian population ages. Both primary and secondary prevention should be important in reducing morbidity due to sarcopenia. The population should be educated to maintain an adequate diet, exercise regularly, and have any medical conditions treated early. Physicians who care for the elderly should be aware of the problem of sarcopenia and be ready to offer remedies. For instance, both healthy (17) and frail nursing home patients (18) have shown considerable improvements in strength and functional status with progressive resistance training. Such exercise may have other health benefits and great potential in the frail, elderly population.

Sarcopenia is an emerging health problem among the aging Asian population. Prospective studies are needed to delineate the natural progression and predisposing factors of the condition. Meanwhile, advocacy on the importance of exercise should benefit all elderly persons.

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