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ORIGINAL ARTICLE

Prevalence of sarcopenia and associated factors among Thai population

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Abstract The purpose of this study was to determine the prevalence of sarcopenia using the skeletal muscle index (SMI) criteria in the Thai population. The secondary objective was to demonstrate factors influencing low SMI in this population. Femoral neck bone mass density (BMD) was measured by dual-energy X-ray absorptiometry (GE Lunar, Madison, WI, USA) in 435 urban and 397 rural subjects (334 men and 498 women) between 20 and 84 years of age. Body mass index (BMI) was calculated from weight and height. The respective prevalence of sarcopenia among men and women was 35.33 % (95 % CI, 29.91, 40.41) and 34.74 % (95 % CI, 30.56, 39.10). Factors associated with sarcopenia using multiple logistic regression analyses in both sexes were (a) living in the city, (b) higher BMI, and (c) older age. Living in an urban area was the strongest factor, with an odds ratio (OR) of 17.26 ± 7.12 (95 % CI, 7.68, 38.76) in men and 8.62 ± 2.74 (95 % CI, 4.62, 16.05) in women ($p < 0.05$). The prevalence rate ratio for persons living in urban compared to rural areas was 2.01 (95 % CI, 1.14, 3.53) in men and 1.69 (95 % CI, 1.31, 2.17) in women ($p < 0.05$). Sarcopenia, as based on SMI, occurs frequently in the Thai population and increases with age. The prevalence of sarcopenia is particularly high among pre-retirement women (50–59 years of age) whereas the number of men with sarcopenia gradually rises with age. An urban environment is the most predictive factor for sarcopenia, followed by high BMI and age. Given the aging population, early recognition of this condition can be beneficial for prevention of an epidemic of sarcopenia-related disability.

Keywords Epidemiology · Aging · Fat-free mass · Skeletal muscle · Skeletal muscle index

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Introduction

Aging is associated with a loss of skeletal muscle mass and a decline in muscle function [1]. The decline in muscle mass is 1–2 % per year after about age 50, whereas muscle strength decreases faster, at a rate of 1.5 % per year between ages 50 and 60 and subsequently at 3 % per year. These are the results of physiological changes including denervation of motor units and a net conversion of fast type II muscle fibers into slow type I fibers, leading to muscle power loss, and a lipid deposition in muscle. The term "sarcopenia" is a condition characterized by loss of muscle mass and muscle strength, and it is one of the main causes of muscle mass loss, followed by anorexia, dehydration, and cachexia [2–4].

The prevalence of sarcopenia varies between 5 and 13 % among the elderly between 60 and 70 years of age, and the figures rises to between 11 and 50 % for those 80 years and older [2]. The estimated prevalence of sarcopenia

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is difficult to determine because of its diverse definitions, the numerous determining methodologies, and the heterogeneity of the populations studied [2–4]. For example, (a) a loss of skeletal mass using the skeletal mass index is defined as muscle mass normalized for height by the bioelectrical impedance (BIA) method; (b) appendicular skeletal muscle mass < 2 standard deviations (SD) below the mean of the young women reference group can be calculated by the dual-energy X-ray absorptiometry (DXA) method; (c) calf muscle cross-sectional ares greater than 2 SD below the population can be determined using computed tomography; (d) skeletal muscle index (SMI) can be determined by the calculation muscle mass/body mass $\times$ 100; and finally (e) sarcopenia class I is defined as SMI 1–2 SD and class II $>$ 2 SD of the mean of young subjects (18–39 years) using the BIA method [2].

Recently, the European Working Group on Sarcopenia in Older People (EWGSOP) has recommended using the presence of both low muscle mass and low muscle function (strength and performance) for the diagnosis of sarcopenia: the diagnosis of which requires evidence of a low muscle mass plus evidence of either low muscle strength or low physical performance. In addition, the severity of sarcopenia can be classified as pre-sarcopenia: low muscle mass alone; sarcopenia: low muscle mass plus low muscle strength or low physical performance; or severe sarcopenia: low muscle mass, low muscle strength, and low physical performance [5].

Several mechanisms of sarcopenia have been documented including alterations in sex hormones, protein synthesis, proteolysis, endocrine issues (insulin resistance, growth hormones, IGF-1, abnormal thyroid function test, glucocorticoids), neuromuscular integrity, and muscle fat content. The causes of this condition can be classified as primary (age-related) sarcopenia and secondary sarcopenia from activity, nutrition, and disease-related causes [4–6]. This condition may affect the quality of life, the need for supportive services, and eventually the need for long-term care. There is evidence that sarcopenia is independently associated with important health outcomes and disabilities in a relatively healthy and ambulatory population [7]. Fortunately, new treatments for sarcopenia are in development, focusing on drug treatment, physical performance, falls, fractures, patient-reported outcomes, and assessing function and quality of life [8]. Recognizing this condition is important to prevent an epidemic of sarcopenia-related disability and the associated catastrophic health and societal costs.

Objectives

The prevalence of sarcopenia in the Thai population is unknown. Therefore, the primary objective of this study was to determine the prevalence of sarcopenia in the Thai population using the SMI, and the secondary objective is to demonstrate factors influencing low SMI in the Thai population.

Materials and methods

Setting and subjects

This was a cross-sectional study. The setting was Bangkok and the province of Khon Kaen, Thailand. Bangkok is the capital, with a population of 5.7 million; Khon Kaen is a rural, largely agricultural, province, located 445 km northeast of Bangkok with a population of 1.8 million. Further details of this study have been described elsewhere [9].

The selected subjects were sent a letter of invitation asking if they would like to participate in the study. The response rate was 80.3 %. In Bangkok, the subjects were recruited via a media campaign, and the sampling technique was similar to the scheme used in Khon Kaen, where subjects were randomly selected from five districts within the city of Bangkok. All the Khon Kaen subjects were farmers; the Bangkok subjects were office, factory, or household workers.

The exclusion criteria were bone disorders; chronic diseases; a history of taking medications deemed to affect calcium and bone metabolism, such as the use of steroids or thyroid hormones; or pregnancy, lactation, delivery, or abortion within the previous 3 months; a previous history of oophorectomy; and premature menopause.

The study was conducted in accordance with the 1975 Helsinki Declaration (revised in 1983) and approved by the Ethics Committee of the Faculty of Medicine Ramathibodi Hospital Mahidol University (Bangkok) and Khon Kaen University (Khon Kaen). Written, informed consent was obtained from all subjects.

Measurements

Bone mineral density (BMD) at the femoral neck (g/cm^2) was measured by DXA with a Lunar DXP-IQ densitometer (GE Lunar, Madison, WI, USA). In addition, a whole body scan was performed, from which estimates of fat mass and muscle mass (lean mass) were obtained. Percentages of body fat (%BF) were calculated as the percent of fat mass in relationship to body weight. The two study sites (Bangkok and Khon Kaen) used the same model of the DXA machine and the same protocol for taking the measurements. Body weight (including light indoor clothing) was measured using an electronic balance (accurate to 0.1 kg) and standing height (without shoes) with a

stadiometer (to the nearest 0.1 cm). The body mass index (BMI) was the ratio of weight (kg) over height squared (m^2).

Statistical analyses

The baseline characteristics were summarized using frequency and percentage for categorical variables. For the continuous variables, the mean and SD were determined. When the continuous variable was not normally distributed, the median, minimum, maximum, and inter-quartile ranges were determined.

The factors associated with low SMI were evaluated using multiple logistic regression. An exploratory data analysis of the prevalence rate ratio (PRR) for persons living in urban versus rural areas for different age groups was also performed.

All the data analyses were performed using STATA version 10.0 (StataCorp, College Station, TX, USA).

Results

The study recruited 832 individuals: 498 women and 334 men. Characteristics of the participants are shown in Table 1. The prevalence of low relative skeletal muscle mass or sarcopenia as per SMI by sex, classified as normal or sarcopenia class I and II, is presented in Figs. 1 and 2 [1, 10, 11]. The prevalence of sarcopenia was 35.33 % (95 % CI, 29.91, 40.41) and 34.74 % (95 % CI, 30.56, 39.10) in men and women, respectively.

The various factors associated with low SMI according to the multivariate analysis are shown in Table 2. Living in an urban area, higher BMI, and older age were significantly associated with low SMI. Living in an urban area had the strongest association with low SMI. A subgroup analysis for the prevalence rate ratio for persons living in an urban versus rural area for different age groups was performed (Table 3). The statistically significant results were 2.01 (95 % CI, 1.14–3.53) and 1.69 (95 % CI, 1.31–2.17) in men and women, respectively.

Table 1 Descriptive characteristics of participants

Characteristics	Women	Men
$N = 832$(%)	498 (59.86 %)	334 (40.14 %)
Age (years)		
Mean ± SD	50.45 ± 15.54	49.34 ± 17.26
Median (min, max)	52 (20, 84)	49 (20, 82)
Living in urban area, *n* (%)	254 (51 %)	181(54.19 %)
Body weight (kg)		
Median (min, max)	54.6 (31.4, 97.1)	59.5 (32, 104.1)
Height (m)		
Median (min, max)	153.5 (137.2, 171.4)	163 (146, 181.5)
BMI (kg/m^2) (mean ± SD)	23.65 ± 3.94	22.83 ± 3.25
BMD at femoral neck (g/cm^2)		
Median (min, max)	0.82 (0.41, 1.36)	0.9 (0.52, 1.44)
Fat mass (kg)		
Median (min, max)	17.91 (1.65, 49.41)	9.86 (1.79, 30.71)
Muscle mass (kg)		
Median (min, max)	33.57 (23.75, 51.71)	46.53 (27.08, 75.53)
Osteoporosis at femoral neck (%)	8	4.5
Body fat (%)	34.48 ± 8.12	17.99 ± 7.89

Osteoporosis, BMD 2.5 SD or more below the young adult reference mean (T score ≤ -2.5)

SD standard deviation, *min* minimum, *max* maximum, *BMI* body mass index, *BMD* bone mass density

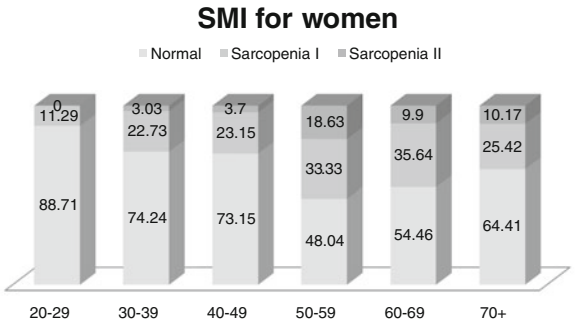

Fig. 1 Prevalence of low relative skeletal mass in different age groups (*x*-axis, years) in women. *SMI* skeletal muscle index

Discussion

This is a subgroup study of the "Effect of urbanization on BMD: a Thai epidemiological study" [9]. Low relative skeletal muscle mass based on the SMI is prevalent in the Thai population, affecting about one-third of the participants, independent of gender. The prevalence among men trended to rise slowly with age whereas among women it peaks between 50 and 59 years. Among women in the age group between 40 and 49 years and that between 50 and 59 years of age, the prevalence of sarcopenia nearly doubled, whereas the rate increased gradually among men. Factors associated with low SMI in this study were living in an urban area, BMI, and age (both sexes). The subgroup analysis revealed that the prevalence rate ratio of men living in urban versus rural areas was statistically significant among all age groups (particularly in those under 60 years of age) and for all men with a low SMI living in an urban area.

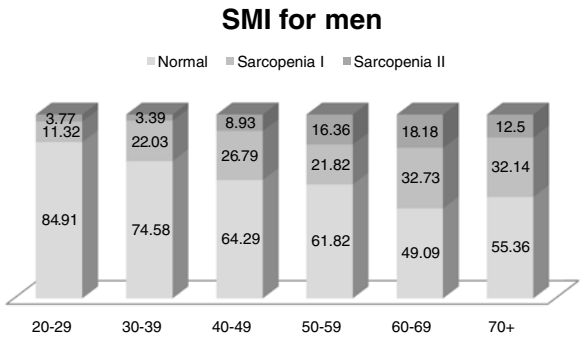

Fig. 2 Prevalence of low relative skeletal mass in different age groups (*x*-axis, years) in men. *SMI* skeletal muscle index

Table 2 Factors associated with low skeletal mass index (SMI)

Factors	Men			Women		
	OR	(SD)	95 % CI	OR	(SD)	95 % CI
Living in urban area	17.26	(7.12)*	7.68, 38.76	8.62	(2.74)*	4.62, 16.05
BMI (kg/m^2)	2.11	(0.20)*	1.75, 2.56	1.87	(0.11)*	1.65, 2.10
Age (years)	1.04	(0.01)*	1.02, 1.07	1.03	(0.01)*	1.01, 1.05
Osteoporosis at femoral neck	2.19	(1.91)	0.4, 12.12	0.78	(0.5)	0.23, 2.67

OR odds ratio, *SD* standard deviation, *CI* confidence interval

* Significant at $p < 0.05$

Table 3 Prevalence rate ratio (PRR) for persons living in an urban versus rural area for different age groups

Age group (years)	*N* (M/W)	Men			Women		
		PRR	95 % CI	*p* value	PRR	95 % CI	*p* value
Overall	334/498	2.01	1.14, 3.53	<0.05	1.69	1.31, 2.17	<0.05
20–29	53/62	Infinity	–	<0.05	0.43	0.09, 2.04	NS
30–39	59/66	3.49	1.26, 9.7	<0.05	0.79	0.34, 1.82	NS
40–49	56/108	6.54	2.16, 19.83	<0.05	1.99	1.0, 3.96	<0.05
50–59	55/102	7.2	2.39, 21.65	<0.05	1.86	1.24, 2.79	<0.05
60–69	22/101	2.1	1.14, 3.53	<0.05	2.11	1.31, 3.40	<0.05
70+	56/59	2.45	1.27, 4.73	<0.05	2.06	1.01, 4.22	<0.05

N total number of subjects, *PRR* prevalence rate ratio, *NS* no statistical significance, *M* men, *W* women

Our study confirms the existing studies, which showed that the prevalence of sarcopenia increases with age. The prevalence of sarcopenia using SMI as an assessment method in women with sarcopenia class I and II are 30.5 and 10 %, respectively. The respective proportion of men with sarcopenia class I and II was 32.5 and 15.7 %. Compared with a previous study using similar criteria conducted in the United States, the prevalence of class I and II sarcopenia in women was much higher than in our study (59 vs. 10 %, respectively). The overall prevalence in men was similar, but the figures in other studies were a bit higher for sarcopenia class I (45 %) and lower for class II (7 %) [2, 11, 12]. This difference can probably be explained by modifiable factors including lifestyle, physical activity, diet, vitamin D intake, chronic disease, and medication usage [3]. Thailand, particularly in rural areas, is still predominantly an agricultural society, and also it is located in the tropics, so the population has more exposure to sunlight and lives in a different environment than that of the previous studies. Interestingly, the number of women with sarcopenia in the current study was greatest among those between 50 and 59 years, which is pre-retirement age. This aspect may be explained by the change of factors related to sarcopenia in the younger generation compared to the older one such as less physical activity. The results suggest that sarcopenia among those over 60 will increase dramatically in the next one to two decades, considering the expected rise in the elderly population. Any interventions that may prevent or delay the progression of sarcopenia should, therefore, be encouraged.

Factors contributing to sarcopenia in the current study were comparable in both sexes living in urban areas, with a high BMI, and elderly. Urban dwelling, especially among men, was the strongest factor: this can be explained by other causes of sarcopenia apart from age-related sarcopenia, including activity-related and nutritionally related sarcopenia [3]. An urban dweller tends to have a more sedentary lifestyle, less sun exposure, and a diet high in fats and refined carbohydrates and low in fiber [13]. Further studies are required to explore the specific causative factors.

The association of high BMI with sarcopenia found in our study supports the existing evidence that weight gain leads to poor health and physical function [14]. Obesity is one of a number of conditions that can trigger interleukin-6 (IL-6) release, which contributes to an increase in glucocorticoids and catecholamines levels and a decrease in growth and sex hormone levels. This pattern is seen in chronic stress, which shares the mechanism of sarcopenia [5, 7, 15].

A limitation of the study was the retrospective data collection, which preceded the new diagnostic criteria for sarcopenia from the EWGSOP. The prevalence of sarcopenia cannot therefore be estimated, given the lack of data on muscle strength and physical performance. Nevertheless, we can estimate a high prevalence of pre-sarcopenia. Furthermore, the findings herein contribute to knowledge of the relationship of low skeletal muscle mass, lack of participation in physical activity, and co-morbidities to sarcopenia.

Conclusions

Sarcopenia, based on SMI, was common in the Thai population and increases as the elder years progress. Sarcopenia among women was highly prevalent in the pre-retirement period (50–59 years of age) whereas among men it rose gradually with age. An urban environment was the most predictive factor for sarcopenia, followed by high BMI and advancing age. Given the aging population, further studies are needed to explore the specific causative factors, because early recognition could help to prevent or delay its progression.

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Conflict of interest All authors have no conflicts of interest.

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