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The predictors of skeletal muscle mass among young Thai adults: a study in the rural area of Thailand.

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Abstract

Low skeletal muscle mass and its predictors have been studied widely in older adults. There are few data; however, about their association in young Thai adults. The objectives of this study were to identify risk factors of low relative appendicular skeletal muscle mass (RASM) in young adults by sex-specific groups and to determine optimal cut-off points for low RASM for those adults. This was a cross-sectional study. Healthy urban subjects in Khon Kaen, Thailand who were aged 20-39 year were recruited. Baseline characteristics were collected. Body composition estimation was determined using bioelectrical impedance analysis. One-hundred women and 100 men were recruited for this study. The median RASM was 6.13 kg/m^2 in women and 8.01 kg/m^2 in men. The cut-off points for low RASM were 5.68 kg/m^2 in women and 7.22 kg/m^2 in men. For women, increased fat mass (FM), and total body water (TBW) were associated with increased RASM with odds ratios (OR) of 1.04 (95% confidence intervals (CI) 1.02, 1.05) and 1.06 (95%CI 1.02, 1.1). Non-sedentary lifestyles were also related to increased RASM (OR 1.23, 95% CI 1.02, 1.57) whereas current smoking were associated with low RASM (OR 0.45, 95% CI0.21, 0.96). For men, RASM showed a positive association only with FM (OR 1.11, 95% CI 1.07, 1.15) and TBW (OR 1.07, 95% CI 1.04, 1.09). In conclusion, FM and TBW were positively associated with RASM in young Thai adults independent of gender. Current smoking and a sedentary lifestyle were predictors of low RASM in women. The results from this study support the standard cutoff values of low RASM among Asians.

Keywords: Skeletal muscle, Appendicular skeletal muscle mass, Young adults, Risk factors, Rural area.

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Introduction

Skeletal mass loss is a part of the ageing process after reaching a peak in early adulthood, at about 40-45 years of age, it progressively declines about 8% per decade until the age of 70 and about 15% afterward [1, 2] but also is a consequence of acquired conditions including neurodegenerative diseases, endocrinological abnormalities, inadequate nutrition or malabsorption, cachexia and disuse such as in physical inactivity [1]. Moreover, the ageing process is associated with decreased muscle strength and physical performance that are related to an increase of the prevalence of sarcopenia. Sarcopenia is one of the geriatric syndromes that is an age-related decline in skeletal mass and muscle function which is related to physical disability, falls, poor quality of life, adverse metabolic outcomes, increases in healthcare costs and mortality in older adults [3]. According to the consensus of the Asian Working Group for Sarcopenia (AWGS), the diagnosis of this condition requires measurements of muscle mass, muscle strength, and physical performance [3]. There are; however, different cutoff values across ethnicities and gender. Currently, the existing cut-off points for Thai people are in the domains of muscle strength and physical performances [4, 5] but still lacking in the domain of skeletal mass as well as the predictors of skeletal muscle mass. The AWGS recommends the cutoff points to determine low skeletal muscle mass by using 2 standard deviations (SD) below the mean relative appendicular muscle mass (RASM) of a young reference group 20-39 years or the lower quintile of the group, and recommends using height-adjusted skeletal muscle mass instead of weight-adjusted skeletal muscle mass [3]. Factors associated with low skeletal muscle mass of older adults in previous reports are older age, being women, being African-Americans compared to Caucasians, physical disability, physical inactivity, smoking, living in the city as compared to the rural area, lower testosterone and vitamin D levels [2, 6-8]. For body mass index and fat mass, the results are inconsistent as some reports showed positive and some showed negative relationships [6, 9]. As sarcopenia increases with age and many factors related to this condition are reversible and lack study in this area of Thailand, recognizing those factors and their effects on the size of skeletal muscle mass would benefit for early intervention to young adults to delay the consequences of sarcopenia. Thus, the primary objective of this study was to identify risk factors of low skeletal muscle mass in young adults by sex-specific groups, and the secondary objective was to identify optimal cut-off points of low skeletal muscle mass of young Thai adults by specific sex groups.

Methods

Study Subjects

This was a cross-sectional study. Subjects were a sample of young healthy Thai adults who were aged 20-39 years. The potential subjects were sent a letter of invitation asking if they would like to participate in the study. The exclusion criteria were the persons who could not stand upright, had a pacemaker, used drugs, herbs or any hormones that affect muscle mass and strength such as contraceptive drugs, steroid hormones and thyroid hormone, drank alcohol 12 hours prior to the test, had vigorous exercise within 12 hour before analysis, were dehydrated, and women during the menstrual period or pregnancy. The study population was similar to the previously published article [10].

Setting

The setting was Khon Kaen province, Thailand which is the second-largest Northeastern province. It is located 445 km from Bangkok with a population of 1.8 million [6].

Data Collection

Baseline data including age, educational level, smoking status and level of physical activity using the General Practice Physical Activity Questionnaire (GPPAQ) were collected. GPPAQ is a validated screening tool and is correlated to cardiovascular disease risks that provide a simple, 4-level physical activity index (PAI) of; active, moderately active, moderately inactive and inactive or sedentary lifestyles [11]. Body weights and standing heights were taken while subjects were lightly clothed and wore no shoes. Body composition including fat mass (FM), percent body fat (PBF), free fat mass (FFM), total body water (TBW) estimations were determined using the Tanita bioelectrical impedance analysis (BIA) system (model BC-418). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Appendicular skeletal mass (ASM) was determined from the sum of predicted skeletal mass from arms and legs (kg) and then the calculation of relative appendicular skeletal mass (RASM) was derived from ASM (kg) divided by height squared (m^2) [3].

Procedure

Eligible subjects had no food or drink 4 hours prior the test and written informed consent was obtained from all subjects. Baseline data collected by trained nurses included age, sex, educational level, smoking status (never smoked, ex-smoker and current smoker), level of physical activity using GPPAQ, body weight, height, and then body composition which included fat mass, percent body fat, free fat mass, total body water, and appendicular skeletal mass was measured by the body composition monitor with a scale.

Sample Size Calculation

Sample size calculation was based on the primary objective of this study which was based on the factors associated with skeletal muscle mass. It was anticipated that there would be 9 factors associated with ASM among the subjects: age, gender, ethnicity, physical disability, sedentary lifestyle, smoking status, living area (urban or rural area), body mass index and fat mass [2, 6, 7, 12-14]. The sample size estimation was based on the current recommendation among statisticians for multiple logistic regression analysis, i.e., that the number of subjects being five to ten times the number of risk factors in the multiple logistic model [15]. As gender is the strong factor associated with the discrepancy in body composition in many studies, analyzing the data as sex-specific was performed [6, 16]. Gender, ethnicity, living area and physical disability were controlled by the study design; therefore, approximately at least 60 subjects of each sex were needed. This study recruited 100 men and 100 women.

Statistical Analysis

Demographic data were analyzed using descriptive statistics, presentations in percentage, mean and standard deviations. If the distribution of these data was not a normal distribution, then medians, and inter-quartile ranges were used instead. Factors associated with RASM were analyzed using univariate and multiple logistic regressions. Univariate analysis was used to examine all associated factors. Multi-collinearity of those factors was checked, then factors with $P<0.20$ were entered into a multiple logistic regression model with logarithmic transformations. $P<0.05$ was considered to indicate statistically significant differences and adjusted odds ratios (OR) and their 95% confidence intervals (CI) were reported to consider the strength of association between possible factors and RASM. All the data analyses were carried out using STATA version 10.0 (Stata Corp, College Station, Texas).

Ethics approval was provided by the ethics committee of the Faculty of Medicine, Khon Kaen University according to the Helsinki Declaration.

Results

One-hundred men and 100 women were recruited for this study. Baseline characteristics and body compositions are shown in Table 1. The cut-off points of the RASM at the 20th percentile that were used to define having low muscle mass were; for women, 5.68 kg/m^2 and for men, 7.22 kg/m^2.

The factors associated with RASM by gender using univariate analysis models that were adjusted for the baseline characteristics were fat mass and total body water. Seven factors were found to be statistically significant (p<0.2): age, levels of education, smoking status, physical activity, BMI, FM, and TBW. After multicollinearity was checked, BMI was removed from the model. With multiple logistic regressions with logarithmic transformations, 4 of these factors were found to be independently related to RASM in women: smoking status, physical activity, fat mass and total body water. For men, only 2 factors, FM and TBW, showed statistical significance (Tables 2 and 3).

***Table 1:** Baseline characteristics of subjects by gender*

Variables	Women (n=100)		Men (n=100)	
Age (years); med(IQR1,IQR3)	25	(29,34.5)	29	(24,34)
Education				
• ≤ 6 years	13	(13%)	21	(21%)
• > 6 years	87	(87%)	79	(79%)
Smoking status				
• Never smoker	95	(95%)	37	(37%)
• Ex-smoker	4	(4%)	8	(8%)
• Current smoker	1	(1%)	5	(5%)
Sedentary physical activity	15	(15%)	5	(5%)
BW (kg); med(IQR1,IQR3)	55.05	(48.55,63.95)	65.6	(59,73.25)
Height (m); mean (SD)	157.49	(5.91)	169.77	(7.09)
BMI; med(IQR1,IQR3)	22.05	(19.75,26)	23.05	(20.30,25.45)
FM; med(IQR1,IQR3)	17.15	(13.1,24.25)	12.4	(8.55,18.5)
PBF;med(IQR1,IQR3)	32	(26.9,38.05)	19.8	(14.25,24.25)
FFM; med(IQR1,IQR3)	37.3	(35.3,40)	52.85	(48.85,58.15)
TBW; med(IQR1,IQR3)	26.25	(24.3,28.6)	35.25	(32.85,38.85)
ASM; med(IQR1,IQR3)	15.1	(14.2,16.25)	22.4	(20.7,25.25)
RASM				
• Median (IQR1,IQR3)	6.13	(5.75,6.54)	8.01	(7.41,8.61)
• Mean (SD)	6.23	0.73	8.09	1.11

***Table 2:** Factors associated with RASM using linear regression models with logarithmic transformations in women*

Factors	OR	SE	P-value	95% CI
Age	1.01	0.01	0.15	0.99,1.02
Education				
• ≤ 6 years	1			
• > 6 years	0.91	0.10	0.39	0.72,1.13
Smoking status				
• Never smoker	1			
• Ex-smoker	0.87	0.17	0.47	0.59,1.28
• Current smoker	0.45	0.17	0.04*	0.21,0.96
Physical activity				
• Sedentary	1			
• Not sedentary	1.23	0.14	0.03*	1.02,1.57
FM	1.04	0.01	0.00*	1.02,1.05
TBW	1.06	0.02	0.003*	1.02,1.1

Note: RASM; relative appendicular skeletal muscle mass; ASM/ht^2(kg/m^2), FM; fat mass (kg),TBW; total body water (kg), sedentary physical activity is based on the definition of the GPPAQ, OR; odds ratio, SE; standard error, P-value was significant at P<0.05, CI; confidence interval

Table 3: *Factors associated with RASM using linear regression models with logarithmic transformations in men*

Factors	OR	SE	P-value	95% CI
Age	1.01	0.01	0.61	0.98,1.03
Education				
• ≤ 6 years	1			
• > 6 years	1.08	0.21	0.68	0.74,1.6
Smoking status				
• Never smoker	1			
• Ex-smoker	0.82	0.25	0.50	0.45,1.49
• Current smoker	1.16	0.20	0.37	0.83,1.63
Physical activity				
• Sedentary	1			
• Not sedentary	1.01	0.36	0.99	0.49,2.05
FM	1.11	0.21	0.00*	1.07,1.15
TBW	1.07	0.01	0.00*	1.04,1.09

Note: RASM; relative appendicular skeletal muscle mass; ASM/ht^2(kg/m^2), FM; fat mass (kg),TBW; total body water (kg), sedentary physical activity is based on the definition of the GPPAQ, OR; odds ratio, SE; standard error, P-value was significant at P<0.05, CI; confidence interval

Discussion

This study represents the body compositions of young Thai adults in northeastern part of Thailand where there is evidence that the living area is one of the predictors of skeletal muscle mass which was probably due to the activity-related and nutritionally related causes [6]. There is no cut-off value for skeletal muscle mass in young Thai adults as a reference point for detection of low skeletal muscle mass and the AWGS recommends using height-adjusted skeletal muscle mass presented as RASM at the lowest quintile as cut-off points. The optimal cut-off points of low RASM in this study according to the criteria of the AWGS for young Thai adults were 5.68 kg/m^2 in women and 7.22 kg/m^2 in men. The cutoff values determined in this study that are sex specific are close to the references of the recommendation of the AWGS which were 5.7 kg/m^2 in women and 7.0 kg/m^2 in men by using BIA [3]. Therefore, Asian populations appear to have similar standard muscle mass indices even with a diversity of lifestyles and cultural backgrounds.

Factors related with RASM in this study for women were being a current smoker, levels of physical activity, fat mass and total body water. For men, only fat mass and total body water showed the associations. Fat mass and TBW showed positive associations with RASM in both sexes, supporting the evidence that fat mass was a predictor of appendicular muscle mass regardless of sex [9, 12, 16, 17]. The possible explanation is likely the result that the increased muscle mass is related to increased muscle hydration on account of edema or intramuscular fat and probably fibrous tissue deposition [16].

For smoking, it is well-documented that smoking, particularly in current smokers, is associated with low RASM. The potential mechanism is directly from an impairment of muscle protein synthesis and up-regulating genes associated with muscle maintenance [14]. Poor lifestyle habits such as a sedentary lifestyle and poor nutrition are indirect mechanisms of smoking [14]. This study demonstrated this effect only in women who are current smokers though there was only one currently smoking participant. Hormonal differences by gender may play an important role, especially testosterone, which has positive effects on skeletal muscle mass [8]. In addition, previous studies demonstrated the effect of smoking on muscle mass in older adults whereas this study was conducted in young adults. Therefore, this study could not show the effect of smoking on muscle mass in young men [14, 18-20]. The results of this study also confirm the effect of a sedentary lifestyle on muscle mass in females. Physical inactivity causes an imbalance of protein synthesis and breakdown. The activation of different proteolytic systems appears to activate muscle cell damage [14]. For men, there was no statistical difference attributable to sedentary lifestyle. This can be explained by the comparable reasons described for smoking, hormonal differences and age effects [18, 19]. Age showed no association with low muscle mass in young Thai adults after controlling for other variables whereas it is one of the significant factors among older adults in many studies [7, 8, 12]. This indicates that muscle damage that is related to low skeletal muscle mass index does not occur before the age of 40, supporting the prior reviews [1, 2].

The limitations of this study were the factors that might be associated with skeletal mass in young adults such as testosterone levels that were not measured. In addition, the results might not be generalized to different populations.

In conclusion, the results from this study confirm the standard cutoff values of low RASM among Asians as recommended by the AWGS. Age-related changes in muscle do not appear to effect skeletal muscle mass in young adults. Fat mass and total body water are positively associated with RASM independent of gender whereas lifestyle habits including current smoking and sedentary lifestyle are predictors for low ASM in young Thai women. This study emphasizes the importance of lifestyle modification in young adults, even in men, because there is no harm done by improving lifestyle. The cost effectiveness would be superior to the cost of treatments when adverse outcomes of low ASM exist.

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Disclosures

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References

1. Kim TN, Choi KM. Sarcopenia: Definition, epidemiology, and pathophysiology. J Bone Metab 2013; 20: 1-10.
2. Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J Am Geriatr Soc 2002; 50: 889-896.
3. Chen LK, Liu LK, Woo J, Assantachai P, Auyeung TW, Bahyah KS. Sarcopenia in Asia: consensus report of the Asian working group for sarcopenia. J Am Med Dir Assoc 2013; 15: 95-101.
4. Assantachai P, Muangpaisan W, Intalapaporn S, Sitthichai K, Udompunturak S. Cut-off points of quadriceps strength, declines and relationships of sarcopenia-related variables among Thai community-dwelling older adults. Geriatr Gerontol Int 2014; 14: 61-68.
5. Praditsuwan R, Dajpratham P, Kuptniratsaikul V. The Timed Up & Go: a practical basic mobility skills assessment in the elderly. Siriraj Med J 2006; 58: 588-591.
6. Pongchaiyakul C, Limpawattana P, Kotruchin P, Rajatanavin R. Prevalence of sarcopenia and associated factors among Thai population. J Bone Miner Metab 2013; 31: 346-350.
7. Gallagher D, Visser M, De Meersman RE, Sepulveda D, Baumgartner RN, Pierson RN. Appendicular skeletal muscle mass: effects of age, gender, and ethnicity. J Appl Physiol 1997; 83: 229-239.
8. Baumgartner RN, Waters DL, Gallagher D, Morley JE, Garry PJ. Predictors of skeletal muscle mass in elderly men and women. Mech Ageing Dev 1999; 107: 123-136.
9. Newman AB, Kupelian V, Visser M, Simonsick E, Goodpaster B, Nevitt M. Sarcopenia: alternative definitions and associations with lower extremity function. J Am Geriatr Soc 2003; 51: 1602-1609.
10. Limpawattana P, Kengkijkosol T, Assantachai P, Krairit O, Pimporm J. The performance of obesity screening tools among young Thai adults. J Community Health 2014; 39: 1216-1221.
11. Physical activity policy, health improvement directorate. General practise physical activity questionnaire. London: National Health Service; 2009.
12. Janssen I. The epidemiology of sarcopenia. Clin Geriatr Med 2011; 27: 355-363.
13. Hughes VA, Frontera WR, Roubenoff R, Evans WJ, Singh MA. Longitudinal changes in body composition in older men and women: role of body weight change and physical activity. Am J Clin Nutr 2002; 76: 473-481.
14. Rom O, Kaisari S, Aizenbud D, Reznick AZ. Lifestyle and sarcopenia-etiology, prevention, and treatment. Rambam Maimonides Med J 2012; 3: e0024.
15. Katz MH. Multivariable Analysis: a practical guide for clinicians. 2nd ed Cambridge: Cambridge University Press; 1999.
16. Proctor DN, O'Brien PC, Atkinson EJ, Nair KS. Comparison of techniques to estimate total body skeletal muscle mass in people of different age groups. Am J Physiol 1999; 277: E489-495.
17. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. J Appl Physiol (1985) 2000; 89: 465-471.
18. Castillo EM, Goodman-Gruen D, Kritz-Silverstein D, Morton DJ, Wingard DL, Barrett-Connor E. Sarcopenia in elderly men and women: the Rancho Bernardo study. Am J Prev Med 2003; 25: 226-231.
19. Szulc P, Duboeuf F, Marchand F, Delmas PD. Hormonal and lifestyle determinants of appendicular skeletal muscle mass in men: the MINOS study. Am J Clin Nutr 2004; 80: 496-503.
20. Petersen AM, Magkos F, Atherton P, Selby A, Smith K, Rennie MJ. Smoking impairs muscle protein synthesis and increases the expression of myostatin and MAFbx in muscle. Am J Physiol Endocrinol Metab 2007; 293: E843-848.

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