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COMPARISON OF SKELETAL MUSCLE MASS TO FAT-FREE MASS RATIO BETWEEN JAPANESE-BRAZILIANS AND JAPANESE

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Abstract: *Background:* It is unclear whether there are differences in absolute and relative skeletal muscle mass (SMM) between Japanese-Brazilians living in Brazil and Japanese living in Japan. *Objective:* To compare the SMM to fat-free mass (FFM) ratio as well as body composition. *Design, setting, and participants:* Eighty-four Japanese living in Tokyo and 85 Brazilians and 28 Japanese-Brazilians living in Sao Paulo were recruited for this cross-sectional study. *Measurements:* Muscle thickness (MTH) and subcutaneous fat thickness (FTH) were measured by B-mode ultrasound at nine anatomical sites on the anterior and posterior aspects of the body. Percentage body fat was estimated from FTH, and FFM was calculated. Total SMM was estimated using an ultrasound-derived prediction equation from MTH. *Results:* Body mass index were similar among the ethnic groups in men and women, while percent body fat was lower in Japanese than in Brazilians and Japanese-Brazilians. In men, absolute FFM and SMM were lower in Japanese-Brazilians than their Japanese and Brazilian counterparts. In women, there was no significant difference in absolute FFM among ethnic groups, but absolute SMM was lower in Brazilians and Japanese-Brazilians than in Japanese. As a result, the SMM:FFM ratio was lower in Brazilians and Japanese-Brazilians than in Japanese in men and women. *Conclusion:* SMM:FFM ratio was lower in both Brazilians and Japanese-Brazilians compared to Japanese, which may be associated with environmental factors.

Key words: Ultrasound, body composition, racial difference, muscle thickness, environmental variation.

Introduction

Skeletal muscle is the largest non-fat tissue component of the human body and can account for about 40% of fat-free body mass in young adults (1). Several studies observed a strong correlation between total skeletal muscle mass (SMM) and fat-free mass (FFM) in different ethnic groups (1-3). These studies also reported an increase in the ratio of total SMM to FFM (SMM:FFM ratio) with greater absolute FFM (1-3). Thus, the SMM:FFM ratio may be constant when absolute FFM is similar among ethnic groups. Recently, we reported that the SMM:FFM ratio is similar between Japanese and German men and women after adjusting for age and body mass index, although absolute values of SMM and FFM were higher in Germans than in Japanese. In Brazilian men and women, however, the SMM:FFM ratio was lower compared with Japanese even if FFM was similar between two groups (4). SMM achieved in later life is determined by both peak SMM attained in early life and rate of age-related muscle loss. Thus higher SMM:FFM ratio may present as an advantage for delaying or preventing sarcopenia.

Underlying factors contributing to the difference in the SMM:FFM ratio between Brazilians and Japanese is unclear, but may be associated with several factors such as heredity and environment (e.g., living conditions, physical activity level, nutritional state). Japanese immigrants living in Brazil have a different environment and lifestyle from Japanese living in Japan. Recent evidence suggests that change in nutritional state is regarded as an important contributing factor in skeletal muscle loss (5). Thus the purpose of this study was to compare the SSM:FFM ratio as well as anthropometric variables and body composition of Japanese living in Japan with Brazilians and Japanese-Brazilians living in Brazil with similar body mass index (BMI) ranges.

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Methods

Subjects

Eighty-four Japanese (37 men and 47 women) living in Tokyo and 85 Brazilians (39 men and 46 women) and 28

Japanese-Brazilians (20 men and 8 women) living in Sao Paulo were recruited through printed advertisement and by word of mouth. The Japanese-Brazilians were second-generation (children of first generation, born in Brazil) or third-generation (children of the second generation, born in Brazil). Prior to obtaining informed consent, a written description of the purpose of the study and its safety was distributed to potential subjects. All subjects were healthy and free of overt chronic disease and orthopedic abnormality as assessed by self-report. Candidates with clinically relevant cardiovascular or musculoskeletal disease, as well as those with cancer or previous stroke, were excluded from the study. The subjects with BMI >27 kg/m2 or <18 kg/m2 were also excluded. In each ethnic group, rates of habitual recreational exercise and sports activities (more than once a week) ranged between 40 and 51% for men being physically active and between 43 and 60% of the women being active. The study was conducted according to the Declaration of Helsinki and was approved by the Ethics Committee for Human Experiments of the academic institute.

Assessments of BMI and body composition

Body mass and standing height were measured using a height scale and an electronic weight scale. BMI was defined as body mass divided by height in meters squared (kg/m^2). Selected anthropometric measures were obtained bilaterally from all subjects, as described previously (6). Body density was estimated from subcutaneous fat thickness using an ultrasound-derived prediction equation (6). We have reported previously that the standard error of the estimate (SEE) of body density, calculated using the ultrasound equations, is approximately 0.006 g/mL (or an error of about 2.5% body fat) in the normal-weight Japanese population (6). Percentage of body fat was calculated from body density using the equation of Brozek et al. (7). FFM was estimated as the difference between total body mass and fat mass.

Measurements of skeletal muscle mass

Muscle thickness (MTH) was measured using B-mode ultrasound (Aloka SSD-500, Tokyo, Japan) at nine anatomical sites on the anterior and posterior aspects of the body as has been described previously (6). The measurements were taken while the subjects stood with their elbows and knees extended and relaxed. A 5-MHz scanning head was placed on the measurement site without depressing the dermal surface. The subcutaneous adipose tissue-muscle interface and the muscle-bone interface were identified from the ultrasonic image, and the distance between two interfaces was recorded as MTH. Total SMM was estimated from ultrasound-derived prediction equations (8). A strong correlation (R2=0.94) was observed between magnetic resonance imaging–measured SMM and ultrasound-predicted SMM (8).

Statistical analysis

Results are expressed as means and standard deviations. The differences between groups in the primary outcome variables, including anthropometric variables and body composition, were tested for significance by 1-way analysis of variance (ANOVA), followed by pairwise comparisons using Tukey's multiple comparison procedure if a significant F test was obtained. P-values <0.05 were considered statistically significant.

Results

There were no significant differences in age, height, weight and BMI among ethnic groups in either men and women (Table 1). Waist to hip ratio (WHR) was higher in Brazilian men than in Japanese men, but there was no significant difference in WHR among ethnic groups in women. Percent body fat was lower in Japanese men and women than in Brazilians and Japanese-Brazilians. In men, absolute FFM and SMM were lower in Japanese-Brazilians than their Japanese and Brazilian counterparts. FFM index was similar among the groups, while SMM index was lower in Brazilians and Japanese-Brazilians than in Japanese. In women, there was no significant difference in absolute and relative FFM among ethnic groups, but absolute and relative SMM were lower in Brazilians and Japanese-Brazilians than in Japanese. As a result, the SMM:FFM ratio was lower in Brazilian and Japanese-Brazilian men and women than in Japanese counterparts.

Discussion

In the present study, our results demonstrated that SMM:FFM ratio is lower not only in Brazilians but also in Japanese-Brazilians compared to Japanese. Previously, ethnic differences in body composition have been investigated. Rush et al. (9) investigated ethnic differences in appendicular SMM to assess using dual-energy X-ray absorptiometry (DXA). They reported that the highest appendicular SMM as well as FFM was seen in the Pacific Island group and the lowest appendicular SMM was seen in Asian Indians for both sexes, both before and after adjustment for age, height, and weight. However, the appendicular SMM and FFM in the Pacific Island group and Asian Indians were, respectively, 29.5 and 69.7 kg, and 21.6 and 50.9 kg, for men, and 19.7 and 49.8 kg, and 14.2 and 36.3 kg, for women. We calculated the appendicular SMM:FFM ratio using these reported

Table 1
Body composition and skeletal muscle mass in Japanese, Brazilians, and Japanese-Brazilians

	Japanese	Brazilian	Japanese-Brazilian	p
Men (n=96)	37	39	20	
Age, years	27.6 (3.7)	28.2 (4.2)	28.2 (4.0)	.525
Height, m	1.70 (0.06)	1.70 (0.07)	1.68 (0.05)	.173
Weight, kg	63.1 (7.8)	65.3 (6.9)	61.8 (7.3)	.094
BMI, kg/m^2	21.9 (1.9)	22.5 (1.3)	22.0 (2.6)	.136
Waist-hip ratio	0.82 (0.05)	0.87 (0.04)*	0.85 (0.05)	<.001
Body fat, %	16.3 (4.1)	19.9 (3.9)*	19.2 (4.5)*	<.001
FFM, kg	52.7 (6.1)	52.1 (4.8)	49.7 (4.1)*#	.040
FFM index, kg/m^2	18.3 (1.3)	18.0 (0.9)	17.7 (1.3)	.080
SMM, kg	24.4 (3.7)	23.3 (2.9)	21.7 (2.3)*#	.003
SMM index, kg/m^2	8.5 (1.0)	8.0 (0.6)*	7.7 (0.8)*	.001
SMM:FFM ratio, %	46.2 (3.1)	44.7 (2.5)*	43.7 (2.1)*	.001
Women (n=101)	47	46	8	
Age, years	25.0 (5.4)	24.5 (4.9)	25.1 (8.3)	.858
Height, m	1.58 (0.05)	1.57 (0.06)	1.55 (0.06)	.189
Weight, kg	52.2 (4.8)	52.2 (6.2)	52.6 (2.8)	.979
BMI, kg/m^2	20.8 (1.5)	21.1 (1.6)	21.9 (1.6)	.140
Waist-hip ratio	0.72 (0.03)	0.73 (0.03)	0.74 (0.05)	.570
Body fat, %	23.5 (4.2)	25.9 (4.2)*	28.7 (4.6)*	.001
FFM, kg	39.9 (3.2)	38.5 (3.5)	37.4 (2.3)	.050
FFM index, kg/m^2	15.9 (1.1)	15.6 (0.8)	15.6 (0.7)	.130
SMM, kg	15.2 (2.3)	13.2 (2.0)*	13.1 (1.5)*	<.001
SMM index, kg/m^2	6.1 (0.8)	5.3 (0.5)*	5.5 (0.5)*	<.001
SMM:FFM ratio, %	38.0 (3.4)	34.2 (3.0)*	35.0 (3.1)*	<.001

Abbreviations: BMI, body mass index; FFM, fat-free mass; SMM, skeletal muscle mass; *Significant difference with Japanese; #Significant difference with Brazilian

values and found almost identical values between the Pacific Island and Asian Indian men (42.3% and 42.4%, respectively) and women (39.6% and 39.1%, respectively). Aleman-Mateo et al. (10) also reported ethnic differences in DXA-measured appendicular SMM among Mexicans, African Americans, and Caucasians. The appendicular SMM:FFM ratios were similar between Mexican and Caucasian men and women, even though absolute appendicular SMM was significantly lower in Mexicans. Furthermore, our previous study (4) showed that there was no significant difference in SMM:FFM ratio between German and Japanese men and women after adjusting for age and BMI. However, the results are similar with the present study that the SMM:FFM ratio was lower in Brazilians than in Japanese. Surprisingly, results in the present study demonstrated that Japanese-Brazilians who share the same genetic pattern as Japanese had lower SMM:FFM ratio compared to Japanese. Because FFM index was similar among ethnic groups in both men and women, the reason for the difference in SMM:FFM ratio would be due to lower SMM in Japanese-Brazilians and Brazilians. Therefore, our results indicate that environmental factors may contribute to lower SMM:FFM ratio in Japanese-Brazilians as well as Brazilians.

Physical activity may influence changes in the SMM:FFM ratio. It is an undeniable fact that resistance training and vigorous physical activity are a potent stimulus for muscle hypertrophy and strength gain and it is well known power event athletes have a greater FFM than nonathletes (11). There is a strong correlation between FFM and SMM as well as between FFM and organ tissue mass (e.g., liver, kidneys) in athletes and nonathletes (11). Resistance exercise and/or vigorous physical activity-induced increases in SMM are probably associated with increases in organ tissue mass or other muscle-free FFM. Therefore, any difference in physical activity level between ethnic groups, if this exists, may not be a major contributor to change in SMM:FFM ratio.

Nutritional status could be a factor in the lower SMM:FFM ratio observed in Japanese-Brazilians and Brazilians. Deficient energy intake, not matched by lower levels of energy expenditure, can lead to poor development of muscle mass during growth. Additionally, consuming small amounts of food may result in insufficient protein intakes as well as deficiencies in other important nutrients. Houston et al. (5) reported a greater loss of appendicular SMM over 3 years among older men and women who had low energy-adjusted protein intakes at baseline. Dillon et al. (12) also reported that chronic essential amino acid supplementation improved lean body mass and basal muscle protein synthesis in older adults. Therefore, adequate protein and/or amino acid supplementation may have the potential to protect age-related loss of SMM. In addition, based on animal studies, chronic feeding of a high fat diet in young mice results in the attenuation of SMM growth in response to increased mechanical load (13). On the other hand, muscle protein synthesis is improved in rats fed an oleate-enriched diet (14). However, it is unclear whether poor nutrient and/or micronutrient intake is associated with a decrease in the SMM:FFM ratio, especially during periods of growth. Additional research into these issues is needed.

In conclusion, the findings from this cross-sectional study suggest that the SMM:FFM ratio was lower in both young Brazilians and Japanese-Brazilians compared to young Japanese. The difference in the SMM:FFM ratio between two ethnic groups may be associated with environmental factors. SMM achieved in later life is not only determined by rate of age-related muscle loss, but also reflects the peak attained in early life. Therefore, higher SMM:FFM ratio obtained in youth and early adulthood may delay or prevent sarcopenia. Future longitudinal studies are needed to investigate these findings further.

Conflict of Interest statement: None of the authors had financial or personal conflict of interest with regard to this study.

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