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Research Article,

Physical Fitness of Young Japanese Adults Evaluated by Old and New Diagnostic Criteria for Sarcopenia

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Abstract:

The purpose of this study was to compare the fitness levels of healthy young Japanese adults based on the "old" and "new" sarcopenia versions of the European Working Group on Sarcopenia in the Older People (EWGSOP1 and EWGSOP2) and the Asian Working Group for Sarcopenia (AWGS 2014 and AWGS 2019) criteria. Sixty-nine Japanese young adults were evaluated using the diagnostic criteria and classification of sarcopenia (muscle strength, physical ability, and muscle mass). For both sexes, the percentage classified as "robust" on the sarcopenia diagnostic criteria was lower in "old" than in "new" classification. The "sarcopenia" category comprised 2% of females only, but none of them had "severe sarcopenia". The proportion of participants with "presarcopenia" (old classification) was 19-38% and that with "possible sarcopenia" (new classification) was 2% for females only. A higher proportion of healthy young adults were classified as "robust" in "new" compared to "old" because "presarcopenia" was eliminated in "new". Moreover, since the proportion of low muscle mass exists in one-fifth of males and one-third of females, it would be difficult to use the new criteria to promote muscle mass gains and prevent from a young age to care for the future.

Keywords: presarcopenia, skeletal muscle index, university students.

Introduction:

Sarcopenia (age-related loss of skeletal muscle mass), a concept proposed by Rosenberg [1], has been associated with serious problems (e.g., falls, fractures, and reduced activities of daily living) [2, 3, 4] and is recognized as an important issue that contributes to increased health care costs [5]. Therefore, the European Working Group on Sarcopenia in the Older People (EWGSOP1) and the Asian Working Group for Sarcopenia (AWGS 2014) recommended cutoffs for the diagnosis and assessment of sarcopenia; cut-offs for skeletal muscle index (SMI, defined as appendicular skeletal muscle mass/standing height^2), muscle strength (grip strength), and physical ability (e.g., stand-up test) were recommended. These diagnostic criteria have become the most widely utilized consensus on sarcopenia in clinical practice and research globally [6, 7]. Subsequently, based on the results of many studies, EWGSOP1 and AWGS 2014 have published revised diagnostic criteria in 2019 and 2020 as "EWGSOP2" and "AWGS 2019," respectively, to identify sarcopenia at an earlier stage. However, there are no published comparisons using the old and new diagnostic criteria in both EWGSOP1 and AWGS 2014 [8, 9].

The proportion of older people in developed countries has increased remarkably over the past 70 years as a result of increasing global longevity and declining birth rates. Especially, the population aged 65 years and above in Japan is estimated to increase to 28.4% in 2019, which is the highest among 201 countries and regions of the world [10]. Consequently, the number of people who fall under the category of sarcopenia

in Japan may increase significantly, and particular attention should be paid to this issue. Therefore, the purpose of this study was to compare the fitness levels of healthy young Japanese adults from the old and new sarcopenia diagnostic criteria using the AWGS 2014 and 2019. Previous studies have reported that a certain percentage of young adults in Japan are classified as having "presarcopenia" (low SMI that does not affect muscle strength or physical performance) [11, 12, 13] in the EWGSOP1 (2010), but presarcopenia is not present in the classification of other diagnostic criteria. Thus, the classification approach differs between the old sarcopenia diagnoses, EWGSOP1 and AWGS 2014, and the new sarcopenia diagnoses, EWGSOP2 and AWGS 2019. Therefore, in this study, since the target population is Japanese (Asian), AWGS 2014 and AWGS 2019 will be used as the diagnostic criteria, but the classification of sarcopenia will be presented together with those used in the EWGSOP and AWGS systems. Thus, it is anticipated that the establishment of more classifications for the two major diagnostic criteria in the new and old sarcopenia diagnostic criteria will result in young adults being more likely to be classified in any category. Therefore, it may be easier to promote early sarcopenia control measures for young adults. The originality and novelty of this study is that 1) it was targeted at Japanese people, who are known to have the longest life expectancy in the world and are therefore concerned about the high incidence of sarcopenia, 2) it was targeted at healthy young adults, and 3) it aimed to compare the old and new diagnostic criteria for sarcopenia, and examine the differences as a measure to prevent sarcopenia at an early stage in life.

Methods:

Seventy male and female Japanese university students between the ages of 18 and 20 were recruited orally for the "Sports Practice" course conducted at the university. Although one participant had a history of musculoskeletal disease and knee surgery, 69 participants took the "Sports Practice" course without any problems. Before obtaining informed consent, a document explaining the purpose and safety of the study and a questionnaire on lifestyle were handed out to potential participants. Participants in this study were categorized as "recreationally active," and 45 of the 69 participants (12 males, 21 females) regularly participated in aerobic-type exercises (walking, jogging, cycling; 2-3 times per week, for approximately 30 minutes). None had participated in strength/resistance training in the 6 months prior to the study. All participants were free of obvious chronic diseases (angina, myocardial infarction, diabetes, cancer, stroke, etc.) as assessed by annual physical examination. All of the 69 young adults who passed the criteria were included in the data analysis. The principles of the American College of Sports Medicine and Medical Association Declaration of Helsinki guidelines for the use of human participants were adopted for this study. This research was approved by the Ethics Committee of the Seirei Christopher University (approval number: 21004). The normal gait test was carried out on a 6-meter course [6, 7].

Grip strength was evaluated using a factory-calibrated hand dynamometer (TKK 5401; Takei, Tokyo, Japan). All participants were instructed to hold the dynamometer in their right hand in an upright posture with their arms at their sides and elbows extended to 180° without pressing their arms against their bodies. The size of the dynamometer handle was set to a size that the participant felt comfortable with when gripping it (the second joint of the fingers fit). Every participant performed two trials and the highest value of each trial was used for analysis [7].

Body weight and height were used to measure to the nearest 0.1 kg and 0.5 cm, respectively, using a standing height meter and an electronic scale. Body mass index (BMI) was calculated as body mass/height^2 (kg/m^2). A bioelectrical impedance analyzer (BIA) with multiple frequencies, In Body 430 analyzer (Biospace Co., Ltd., Seoul, Korea) was applied in accordance with the manufacturer's guidelines. The BIA estimates body composition by the difference in conductivity based on the different biological properties of each tissue. This body composition analyzer uses a four-pole, eight-point contact electrode system to measure the impedance of the arms, trunk, and legs separately at three different frequencies (5, 50, and 250 kHz) for every segment. Measurements were taken in a standing position with elbows extended and resting quietly in a relaxed position along the trunk. Body weight, BMI, body fat percentage, and lean soft tissue were automatically estimated by In Body for the two upper and two lower limbs.

Skeletal muscle index (SMI; AMM/height^2, kg/m^2) was determined as the total of the two upper limbs and two lower limbs (AMM) [5, 6, 7, 8].

The protocol recommended for calf girth is to measure the maximum value of both calves using an inelastic tape and has moderate to high sensitivity and specificity in the prediction of sarcopenia or low skeletal muscle mass. The reported calf girth cutoff is 32-34 cm in men and 32-33 cm in women, and AWGS 2019 recommends <34 cm in men and <33 cm in women for screening or case finding. An alternative to calf girth is the "yubiwaka" test, in which the index fingers and thumbs of both hands surround the thickest part of the non-dominant calf [14]. If the measurement of the calf just fits or is smaller than the finger ring, the elderly person is at a higher risk for sarcopenia. The SARC-F is a questionnaire that assesses five factors: muscle strength, walking assistance, rising from a chair, stair climbing, and falling. Previous studies in Asia have verified different language versions of the SARC-F and have shown that the results are independently associated with adverse clinical outcomes [8].

Participants carried out the short physical performance battery (SPPB) using the National Institute on Aging protocol. The tests were in the following order: a) upright balance test, b) walking test, and c) stand-up chair test. For the standing balance, participants were required to maintain their posture with their feet side by side, in semi-tandem, and in tandem for 10 seconds, respectively. Scores were set in the range of 0 to 4 (max performance). The walk test was performed to measure the time required to walk 4 m at a standard pace. The stand-up chair test consisted of standing up from a 0.40 m high and 0.30 m deep steel chair with arms across the chest five times. The scores for each category ranged from 0-4. The walk test and stand-up chair test were based on temporal quartiles previously established in large populations; the sum of the three components was the final SPPB score, with a range of 0-12; 12 points indicate the most advanced lower limb function [15, 16].

The AWGS 2014 criteria (grip strength: less than 26 kg for male and less than 18 kg for female; gait speed: less than 0.8 m/sec for both male and female; SMI: less than 7.0 kg/m^2 for male and 5.7 kg/m^2 for female) [6] and the AWGS 2019 criteria (calf girth: less than 34 for male and less than 33 for female; SARC-F (Screening tool for sarcopenia): 4 or more for both male and female; SARC-Calf (Screening tool for sarcopenia): 11 or more for both male and female; 5 sit-up test: 12 or more for both male and female; SPPB: 9 or less for both male and female; grip strength: less than 28 kg for male and less than 18 kg for female; walking speed: less than 1.0 m/sec; SMI: less than 7.0 kg/m^2 for male and 5.7 kg/m^2 for female) [8], sarcopenia was defined according to the following criteria. The "presarcopenia" was defined as only a low skeletal muscle mass that does not affect muscle strength or physical ability. The "possible sarcopenia" was defined as only low muscle strength or physical ability. The "sarcopenia" was defined as low muscle strength or physical ability plus low muscle mass. The "severe sarcopenia" was defined with all three criteria of the definition (low muscle strength, low physical ability, and low muscle mass) being satisfied.

Results are shown as the mean ± standard deviation for all variables. All data were analyzed using the JMP software (ver. 12.0 SAS Institute Inc., Tokyo, Japan). Nonparametric statistical analysis (Wilcoxon signed rank test) was applied to identify differences between male and female groups when the data were observed to be not normally distributed. Statistical significance was defined as $p<0.05$.

Results:

There were differences between the sexes in physical characteristics and fitness levels, but no significant differences in BMI, gait speed, SARC-F and SPPB (Table 1). In this study, the standing height, body weight, and grip strength of the participants were at the same level as the standard physical strength of Japanese people. The results of the relationship between the diagnostic criteria of AWGS 2014 and 2019 indicated that there were no individuals out of the criteria range for gait speed, SARC-F, 5-time stand up test, and SPPB in both males and females. On the other hand, in calf girth and SMM, the proportions that were outside the diagnostic criteria range were 18.8% and 18.8% in males and 32.1% and 37.7% in females, respectively. A proportion of 1.9% was outside the diagnostic criteria for grip strength in females only (Table 2, 3). For both men and women, the percentage classified as “robust” on the sarcopenia diagnostic criteria was

lower in EWGSOP1/AWGS 2014 than in EWGSOP2/AWGS 2019. The "sarcopenia" classification commonly present in EWGSOP1/AWGS 2014 and EWGSOP2/AWGS 2019 had 2% of females only (0% of males), but none of them had "severe sarcopenia". The percentage of participants with "presarcopenia" (EWGSOP1/AWGS 2014 classification) ranged from 19-38%, and the percentage of participants with "possible sarcopenia" (EWGSOP2/AWGS 2019 classification) was 2% for females only (0% for males) (Table 2, 3).

Table 1. The physical characteristics and clinical data in Japanese university male and female

Variable	Male (n=16)		Female (n=53)	
	Mean (SD)	Range	Mean (SD)	Range
Age, years	18.3 (0.5)	18-19	18.4 (0.5)	18-20
Anthropometry assessments				
Standing height, cm	170.2 (6.6) **	160.0-183.5	158.1 (5.6)	146.5-170.0
Body weight, kg	60.2 (8.7) **	48.0-76.7	50.7 (5.8)	41.6-67.9
BMI, kg/ m^2	20.8 (3.2)	17.7-27.7	20.3 (2.1)	16.8-25.9
Assessments for AWGS 2014/2019				
Gait speed, m/s	1.5 (0.3)	1.0-2.1	1.5 (0.3)	1.0-2.2
Body fat, %	13.8 (7.0) **	6.8-32.8	26.2 (4.8)	16.7-34.9
SMM, kg/m^2	7.6 (0.7) **	6.7-9.2	5.9 (0.5)	5.1-7.2
Assessments for AWGS 2019				
Calf girth, cm	36.1 (2.2) **	33.1-39.1	34.1 (1.9)	29.8-39.4
SARC-F, unit	0.2 (0.4) **	0-1	0.6 (0.8)	0-3
SARC-Calf, unit	2.1 (4.1)	0-11	3.8 (5.0)	0-13
5-time chair stand test, sec	6.4 (1.1)	5.4-8.1	5.5	3.7-7.5
SPPB, unit	12.0 (0.0)	-	12.0 (0.0)	-

Data are given mean (standard deviation). BMI: body mass index. SMI: skeletal muscle index. **$p<0.01$, male vs. female.

Table 2. Comparison of sarcopenia diagnostic criteria and rates based on AWGS 2014 in male and female Japanese university students

Category	Robust	Presarcopenia*	Sarcopenia*,#	Severesarcopenia*,#
Male (n=16)	13 (81.3%)	3 (18.8%)	0 (0.0%)	0 (0.0%)
Female (n=53)	33 (62.3%)	19 (37.7%)	1 (1.9%)	0 (0.0%)

*Classification used in EWGSOP. #Classification used in AWGS 2014.

Table 3. Comparison of sarcopenia diagnostic criteria and rates based on AWGS 2019 in male and female Japanese university students

Category	Robust	Possible sarcopenia§, ¶	Sarcopenia§, ¶	Severesarcopenia§, ¶
Male (n=16)	16 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Female (n=53)	52 (98.1%)	1 (1.9%)	1 (1.9%)	0(0.0%)

§Classification categories used in EWGSOP2. ¶Classification categories used in AWGS 2019.

Discussion:

The main findings of this study have been stated here. First, skeletal muscle mass and SARC-Calf were outside the standard range for both men and women, and there was one-fifth to one-third of young adults who were identified as "presarcopenia" in the EWGSOP1 diagnostic criteria. Second, there was one young female with "sarcopenia" in EWGSOP1/AWGS 2014 and EWGSOP2/AWGS 2019.

The standing height, weight, BMI, and grip strength (males: 170.2 cm, 60.2 kg, 20.8 kg/m^2, 43.4 kg; females: 158.1 cm, 50.7 kg, 20.3 kg/m^2, 27.3 kg) in this study were very close to the

Japanese reference values for morphology and physical fitness (male: 171.1 cm, 63.0 kg, 21.4 kg/m^2, 45.8 kg [age 19 years]; female: 158.7 cm, 52.2 kg, 20.7 kg/m^2, 28.4 kg [age 19 years]) [17]. Thus, it indicates that the participants recruited for this study were the general population of healthy young adults in Japan at present.

The new diagnostic criteria establishes the criteria for early identification of individuals at risk for sarcopenia in order to facilitate necessary interventions in community and primary care [8, 9]. Specifically, AWGS 2019 adopts new criteria such as calf-girth, SARC-F, SARC-Calf and 5 times rise test that can (potentially) diagnose sarcopenia due to decreased physical function and muscle weakness. However, to be evaluated as "possible sarcopenia", the results of the grip strength or 5 time rise test, which are assessments of physical function, must be below the criteria. This means that even if the skeletal muscle mass indices such as calf-girth, SARC-F, and SARC-Calf are out of the range of the criteria, they are not reflected in the diagnostic evaluation of sarcopenia. In this study, one-fifth of males and one-third of females had "presarcopenia" in young adults, indicating that insufficient skeletal muscle mass in young adults is seriously increasing. This result is similar to previous studies on young adult females [11, 12, 13]. In particular, "excessive underweight" in young adult women (the pregnant generation) is considered to be a serious problem [18]. For this reason, the concept of "presarcopenia" in the EWGSOP1 was very significant as the classification aimed at educating the younger generation (e.g., the pregnant generation). In fact, in the present study, in one 18-year-old woman, grip strength was already below the diagnostic criteria, indicating that there was a young woman who fell under the category of sarcopenia. For the serious consideration of future care prevention in young adults, it is important to establish not only the diagnostic criteria but also a classification that can be confirmed by many people, including the young generation. Although EWGSOP2 and AWGS2019 are sarcopenia diagnostic criteria that have received extremely high attention worldwide, it is difficult to prevent sarcopenia in young adults using these diagnostic criteria. Further studies are needed to create awareness of sarcopenia in people from an early age, including young adults.

Periodic physical examinations and physical fitness measurements are generally considered one of the most critical health indicators regardless of sex or age, and are widely carried out at the national level in Japan using both anthropometric measurements and simplified field methods [19]. However, the periodic physical examinations in Japan generally measure only body weight and do not include body fat percentage or skeletal muscle mass [20]. Since body fat percentage and skeletal muscle mass, rather than body weight, can be measured to distinguish fat-free mass against adipose tissue, it can be used to assess health status at a young age. Measurement of calf girth is a simple morphological method and has been reported to be an effective method for assessing skeletal muscle mass in healthy young females in situations where body fat percentage cannot be measured [21]. Taken together, these results suggest that increasing skeletal muscle mass and improving body fat mass among healthy young adults in Japan is important for extending healthy life expectancy in the future.

There are several limitations to this study. First, the participants were young adults of Japan, so their physical characteristics and age were very limited. Secondly, the sample size was small. In order to validate the results of this study, it is necessary to execute additional studies with large sample sizes and robust experimental designs in the future. Particularly, since the sample size of male participants was small, it was difficult to argue for sex differences in the present study. Accordingly, further research is needed to address these issues.

Conclusion:

A higher proportion of healthy young males and females were classified as robust in EWGSOP2/AWGS 2019 compared to EWGSOP1/AWGS 2014 because the classification of "presarcopenia" was eliminated in EWGSOP2/AWGS 2019. However, since the proportion of low skeletal muscle mass exists in one-fifth of males and one-third of females, it would have been difficult to promote improvement of skeletal muscle mass from young age in terms of EWGSOP2/AWGS 2019 to prevent care for the future.

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Conflicts of Interest:
The author declares that he has no conflict of interest.

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