Epidemiology of sarcopenia in elderly Japanese

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Abstract Sarcopenia, a degenerative loss of skeletal muscle mass and strength, impacts daily life among the elderly. Because few cohort studies have examined muscle mass, muscular strength, physical performance, and probable confounding factors in detail, the prevalence of sarcopenia among the elderly in Japan is unclear. In this review, we examine the prevalence of sarcopenia based on the criteria of the Asian Working Group for Sarcopenia (AWGS) using a large-scale cohort of randomly selected community-dwelling elderly in Japan. Participants included 949 elderly (479 men and 470 women) aged 65-91 years who participated in the seventh wave examination of the National Institute for Longevity Sciences - Longitudinal Study of Aging between July 2010 and July 2012. The prevalence of low muscle mass was 43.2% in men and 20.2% in women. The prevalence of low muscle strength was 10.0% in men and 21.5% in women, and the prevalence of low physical performance was 5.4% in men and 9.2% in women. The prevalence of sarcopenia based on a diagnosis of low muscle mass, low muscle strength, and low physical performance was 9.6% in men and 7.7% in women. Elderly who were diagnosed with sarcopenia included 1,320,000 men and 1,400,000 women. These data could be of great help to clinicians and healthcare professionals and contribute to the development of prevention and treatment strategies for sarcopenia in Japan.

Keywords : NILS-LSA, AWGS, community-dwelling elderly

Introduction

Nearly 32 million people in Japan are elderly, and it is predicted that this number will continue to increase¹⁾. Sarcopenia, a degenerative loss of skeletal muscle mass and strength associated with aging, accelerates the frailty syndrome and leads to deterioration in the ability to perform activities of daily living (ADL) and in the quality of life in older people^{2,3)}. Epidemiologic studies of sarcopenia can contribute to the establishment of prevention and treatment strategies. However, no study examines the prevalence of sarcopenia among elderly Japanese based on the criteria of the Asian Working Group for Sarcopenia (AWGS), because these criteria were not released until May 2014.

This short review outlines the prevalence of sarcopenia and diagnostic factors including low muscle mass, low muscle strength, and low physical performance based on the criteria of the AWGS⁴⁾, using a large-scale cohort of

randomly selected community-dwelling elderly in Japan.

Overview of the NILS-LSA

The National Institute for Longevity Sciences - Longitudinal Study of Aging (NILS-LSA), a comprehensive longitudinal study of aging, started in November 1997⁵⁾. Participants in this study initially included 2,400 residents aged 40 to 79 years who were age- and gender-stratified random samples selected from the National Center for Geriatrics and Gerontology (former NILS) area. Participants were examined at the NILS-LSA Examination Center every 2 years. All participants provided written informed consent after a detailed explanation of the study.

The NILS-LSA is a facility-based study with access to many types of testing equipment, including magnetic resonance imaging, dual-energy x-ray absorptiometry (DXA), and computed tomography for detailed and comprehensive assessments of aging and geriatric diseases. Examinations used for the diagnosis of sarcopenia, such as medical examinations, gene analysis, blood chemical

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analyses, body composition, anthropometry, nutritional analysis, physical performance, and physical activity, were carried out continuously in the first-wave examination period (1997 to 2000) of the NILS-LSA.

This review presents the prevalence of sarcopenia among elderly who participated in the NILS-LSA. Participants were 949 elderly (479 men and 470 women) aged 65-91 years who completed the seventh-wave examination of the NILS-LSA between July 2010 and July 2012. The number of participants by age decade is shown in Table 1. We calculated the prevalence of low muscle mass using cutoff values for skeletal muscle index (SMI) by DXA; low muscle strength using cut-off values for hand grip strength; and low physical performance using cut-off values for usual gait speed in men and women. We also calculated the prevalence of sarcopenia using the AWGS algorithm. Moreover, differences in scores on the Physical Functioning Component of the Short-Form 36 (SF-36) between the no sarcopenia and sarcopenia groups were compared to evaluate ADL in elderly participants.

Muscle mass assessment

Low muscle mass is a classic definition of sarcopenia⁶⁾. AWGS recommends that appendicular skeletal muscle mass be assessed by DXA or bioelectrical impedance analysis (BIA). SMI is calculated by appendicular skeletal muscle mass divided by height squared (kg/m^2)⁷⁾. Based on the criteria of AWGS, cut-off values for sarcopenia using DXA are $< 7.0 \text{ kg}/\text{m}^2$ in men and $< 5.4 \text{ kg}/\text{m}^2$ in women (Fig. 1). When using BIA, cut-off values are $< 7.0 \text{ kg}/\text{m}^2$ in men and $< 5.7 \text{ kg}/\text{m}^2$ in women. A total body scan performed by DXA (QDR-4500; Hologic, Bedford, MA, USA) was done in the NILS-LSA. Among the elderly of the NILS-LSA, the prevalence of low muscle mass was 43.2% in men and 20.2% in women. The percentage of men with low muscle mass increased with age decade

(Table 1; p for trend < 0.0001 , Cochran-Mantel-Haenszel statistics). However, there was no significant trend for low muscle mass by age decade in women.

Measurement of muscle mass using DXA or BIA may be difficult in non-specialized facilities because the equipment for these tests is expensive. Recent studies reported that the AWGS-recommended cut-off values using DXA can be estimated using the maximal calf circumference in the standing position⁸⁾. The optimal cut-off values were 34.3 cm (sensitivity 89%, specificity 88%) in men and 32.8 cm (sensitivity 78%, specificity 72%) in women⁸⁾.

Muscle strength assessment

Muscular strength is associated with the ability to perform ADL in the elderly⁹⁾. AWGS recommends that muscle strength be assessed using measurements of grip strength⁴⁾. The Smedley-type grip dynamometer is a more inexpensive and smaller device than equipment for measuring muscular strength of the lower limb. Because grip strength measurements are included in the fitness test of the Ministry of Education, Culture, Sports, Science and Technology, measurements of grip strength are well known in Japan.

Based on AWGS, grip strength measurement cut-off values for sarcopenia are $< 26 \text{ kg}$ in men and $< 18 \text{ kg}$ in women (Fig. 1). Among elderly participants in the NILS-LSA, the prevalence of low muscle strength was 10.0% in men and 21.5% in women. The percentage of men and women in the low muscle strength group increased by age decade (Table 1; p for trend < 0.0001 , Cochran-Mantel-Haenszel statistics).

Physical performance assessment

Various tests for physical performance, including the Short Physical Performance Battery (SPPB), gait speed,

Fig. 1 The algorithm of sarcopenia diagnosis presented by AWGS⁴⁾.

and the timed up-and-go test, are recommended by the European Working Group on Sarcopenia in Older People (EWGSOP)³⁾. In practice, the EWGSOP has developed a suggested algorithm based on gait speed measurement as the easiest and most reliable way to identify patients with sarcopenia or those who should undergo screening. AWGS also uses gait speed measurement as a diagnostic criteria for sarcopenia. No exclusive measuring equipment is necessary for gait speed measurements, which can be measured in any corridor.

Based on AWGS, the cut-off values for gait speed for sarcopenia are < 0.8 m/sec in men and women (Fig. 1). We defined a gait speed of < 0.8 m/sec or a gait disturbance as low physical performance, and calculated the prevalence of low physical performance among the elderly in the NELS-LSA. The prevalence of low physical performance was 5.4% in men and 9.2% in women. The percentage of men and women with low muscle strength increased with age decade (Table 1; *p* for trend < 0.0001, Cochran-Mantel-Haenszel statistics).

Algorithm of AWGS

Fig. 1 shows the algorithm for sarcopenia diagnosis pre-

sented by AWGS. Muscle strength and physical performance are assessed by grip strength and usual gait speed. Muscle mass is assessed by DXA or BIA. The elderly who meet the criteria for both low muscle strength and/or low physical performance and low muscle mass are considered to have sarcopenia.

Among the elderly of the NELS-LSA, the prevalence of sarcopenia was 9.6% in men and 7.7% in women. The percentage of men with sarcopenia increased with age decade (Table 1; *p* for trend < 0.0001, Cochran-Mantel-Haenszel statistics). However, there was no significant trend for the prevalence of sarcopenia by age decade in women. In the AWGS algorithm, elderly who meet the criteria for low muscle strength and/or physical performance and do not meet the criteria for low muscle mass are not diagnosed as having sarcopenia. Generally, age-related muscle loss occurs more notably in men than women. In the analysis of the NELS-LSA, there was no significant association between low muscle mass and age in women (Table 1). There may not be a significant association between sarcopenia and age in women because elderly who meet the AWGS criteria for low muscle strength and/or physical performance are definitely diagnosed as sarcopenia cases due to low muscle mass.

Table 1. Prevalence of low muscle mass, muscle strength, physical performance, and sarcopenia among elderly participants of the NELS-LSA

	Prevalence in the NELS-LSA, n(%)			<i>p</i> for trend
	65-74yr	75-84yr	85-yr	
Men (n=479)				
Number of the participants	266	190	23	
Low muscle mass	89 (33.5%)	100 (52.6%)	18 (78.3%)	<0.0001
Low muscle strength	6 (2.3%)	32 (16.8%)	10 (43.5%)	<0.0001
Low physical performance	6 (2.3%)	14 (7.4%)	6 (26.1%)	<0.0001
Sarcopenia	6 (2.3%)	29 (15.3%)	11 (47.8%)	<0.0001
Women (n=470)				
Number of the participants	258	179	33	
Low muscle mass	47 (18.2%)	40 (22.4%)	8 (24.2%)	0.2339
Low muscle strength	31 (12.0%)	54 (30.2%)	16 (48.5%)	<0.0001
Low physical performance	8 (3.1%)	23 (12.9%)	12 (36.4%)	<0.0001
Sarcopenia	13 (5.0%)	21 (11.7%)	2 (6.1%)	0.0837

NELS-LSA: National Institute for Longevity Sciences - Longitudinal Study of Aging.

The cut-offs for low muscle mass were skeletal muscle index values (measured by dual-energy x-ray absorptiometry) < 7.0 kg/m² in men and < 5.4 kg/m² in women.

The cut-offs for low muscle strength, based on hand grip strength, were < 26 kg in men and < 18 kg in women.

The cut-offs for low physical performance, based on usual gait speed values, were < 0.8 m/sec or gait disturbances in men and women.

The elderly who met the cut-off values for both low muscle strength and/or low physical performance and low muscle mass were defined as having sarcopenia.

Trend *p* values were obtained using Cochran-Mantel-Haenszel statistics.

ADL in sarcopenia

Fig. 2 shows the score of the physical functioning component of the SF-36 adjusted for age in the no sarcopenia and sarcopenia groups. In men, the score was significantly lower in the sarcopenia group than in the no sarcopenia group ($p < 0.0001$). However, no significant differences were noted in women. The effect of age-related declines of muscle mass and muscular strength may be stronger in men than women because muscle mass and strength are intrinsically higher in men than women. Moreover, daily housework is mainly carried out by women in the Japanese household¹⁰⁾. Physical activity due to housework may be one factor that helps elderly women maintain the ability to complete ADL. However, because these results were obtained using cross-sectional analysis, it is necessary to examine the longitudinal relationship between sarcopenia and ADL.

Estimate of the prevalence of sarcopenia in Japan

We previously reported an estimate of the prevalence of sarcopenia in Japan calculated by the prevalence of sarcopenia in the NILS-LSA and the elderly population of Japan¹¹⁾. Elderly who were diagnosed with sarcopenia included 1,320,000 men and 1,400,000 women¹¹⁾. Of these, approximately 60% had both low muscle mass and low muscular strength¹¹⁾.

We also estimated that 2,125,000 elderly men and 5,588,000 elderly women¹²⁾ had low muscle strength and/or low physical performance¹²⁾. Of these, 517,000 men and 3,259,000 women did not meet the criteria for sarco-

penia¹²⁾. It may be necessary to provide care to help with disorders of ADL even without a sarcopenia diagnosis in the elderly female population.

Conclusion

In a study of sarcopenia for elderly Japanese, a study of muscle mass progresses compared with a study of muscular strength and physical performance^{8,13-16)}. A decline in muscular strength and physical performance may cause an impediment to daily life among elderly people. Moreover, the criteria of AWGS were only released recently. It is necessary to understand the association between sarcopenia and adverse outcomes, such as mortality and becoming bedridden, based on the criteria of AWGS⁴⁾. Although sarcopenia is a multifactorial geriatric disease³⁾, the interaction between causative factors is unclear. A broad-scale, long-term, longitudinal study that includes detailed examination of medicines, nutrition, physical activity, and genetics in a community-dwelling population is necessary for a complete understanding of the prevalence, risk factors, and overall impact of sarcopenia.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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Fig. 2 Scores on the Physical Functioning Component of the SF-36 between the no sarcopenia group and the sarcopenia group. Values are means $\pm$ standard error. Groups were determined based on the algorithm of AWGS. Scores were adjusted for age. P values were obtained by the general linear model and t-test.

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References

- 1) Cabinet Office, Government of Japan. 2014. White paper on aging society 2014: 2-6 (*in Japanese*).
- 2) Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G and McBurnie MA. 2001. Cardiovascular Health Study Collaborative Research Group: Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 56: M146-M156.
- 3) Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, Martin FC, Michel JP, Rolland Y, Schneider SM, Topinková E, Vandewoude M and Zamboni M; European Working Group on Sarcopenia in Older People. 2010. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing* 39: 412-423.
- 4) Chen LK, Liu LK, Woo J, Assantachai P, Auyeung TW, Bahyah KS, Chou MY, Chen LY, Hsu PS, Krairit O, Lee JS, Lee WJ, Lee Y, Liang CK, Limpawattana P, Lin CS, Peng LN, Satake S, Suzuki T, Won CW, Wu CH, Wu SN, Zhang T, Zeng P, Akishita M and Arai H. 2014. Sarcopenia in Asia: consensus report of the Asian working group for sarcopenia. *J Am Med Dir Assoc* 15: 95-101.
- 5) Shimokata H, Ando F and Niino N. 2000. A new comprehensive study on aging--the National Institute for Longevity Sciences, Longitudinal Study of Aging (NILS-LSA). *J Epidemiol* 10: S1-S9.
- 6) Rosenberg IH. 1989. Summary comment. *Am J Clin Nutr* 50: 1231-1233.
- 7) Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, Garry PJ and Lindeman RD. 1998. Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol* 147: 755-763.
- 8) Kawakami R, Murakami H, Sanada K, Tanaka N, Sawada SS, Tabata I, Higuchi M and Miyachi M. Calf circumference as a surrogate marker of muscle mass for diagnosing sarcopenia in Japanese men and women. *Geriatr Gerontol Int* (*in press*).
- 9) Al Snih S, Markides KS, Ottenbacher KJ and Raji MA. 2004. Hand grip strength and incident ADL disability in elderly Mexican Americans over a seven-year period. *Aging Clin Exp Res* 16: 481-486.
- 10) Gender Equality Bureau Cabinet Office. 2010. White Paper on Gender Equality 2010. 6-45 (*in Japanese*).
- 11) Yuki A, Ando F and Shimokata H. 2014. Transdisciplinary approach for sarcopenia. Sarcopenia: definition and the criteria for Asian elderly people. *Clin Calcium* 24: 1441-1448 (*in Japanese*).
- 12) Yuki A, Ando F and Shimokata H. 2015. Epidemiology of sarcopenia among the elderly in the NILS-LSA. *The Medical Frontline* 70 (*in press*).
- 13) Sanada K, Miyachi M, Tanimoto M, Yamamoto K, Murakami H, Okumura S, Gando Y, Suzuki K, Tabata I and Higuchi M. 2010. A cross-sectional study of sarcopenia in Japanese men and women: reference values and association with cardiovascular risk factors. *Eur J Appl Physiol* 110: 57-65.
- 14) Yuki A, Otsuka R, Kozakai R, Kitamura I, Okura T, Ando F and Shimokata H. 2013. Relationship between low free testosterone levels and loss of muscle mass. *Sci Rep* 3: 1818.
- 15) Miyakoshi N, Hongo M, Mizutani Y and Shimada Y. 2013. Prevalence of sarcopenia in Japanese women with osteopenia and osteoporosis. *J Bone Miner Metab* 31: 556-561.
- 16) Kasai T, Ishiguro N, Matsui Y, Harada A, Takemura M, Yuki A, Kato Y, Otsuka R, Ando F and Shimokata H. Sex- and age-related differences in mid-thigh composition and muscle quality determined by computed tomography in middle-aged and elderly Japanese. *Geriatr Gerontol Int* (*in press*).