Validity of Two Simplified Algorithms of the Asian Working Group for Sarcopenia Consensus for Diagnosis of Sarcopenia in Rural Community-Dwelling Older Adults in Korea

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Research article

Abstract

Background: Sarcopenia, i.e., the decline of skeletal muscle tissue with age, is a key cause of functional deterioration and loss of independence in older adults, and increases the risks of fall, hospitalization, and mortality; it requires active prevention and management of sarcopenia in community-dwelling older adults. Existing diagnostic criteria for sarcopenia have typically been developed for European populations and may not be applicable to Asian populations. The present study aimed to identify the prevalence of sarcopenia in community-dwelling Korean older adults, and validate two simplified diagnostic algorithms based on the Asian Working Group for Sarcopenia (AWGS) algorithm for identifying sarcopenia.

Methods: This cross-sectional study was conducted on 388 community-dwelling older adults (254 women and 134 men, with a mean age of 77.8 ± 6.26 years [range, 65−93 years]), from a rural area in Korea. Muscle strength was measured by hand grip strength, physical performance by gait speed, and muscle mass by skeletal muscle mass index (SMI). Sarcopenia was assessed using the AWGS-recommended algorithm as well as two simplified algorithms (A and B). Algorithms A and B were validated with respect to the AWGS-recommended algorithm using the chi-square test, and the sensitivity and specificity were obtained.

Results: The prevalence of sarcopenia, determined using the AWGS-recommended algorithm, was 41.7% and 40.3% in men and women, respectively. The overall prevalence of sarcopenia was 39.2% by the AWGS-recommended algorithm, 37.6% by algorithm A, and 37.6% by algorithm B; 137 participants were classified as sarcopenia by all three methods (p = .223).

Conclusion: We established the prevalence of sarcopenia among rural community-dwelling adults in Korea and confirmed that the simplified algorithms were suitable for identification of sarcopenia in rural community-dwelling older adults in Korea. Further studies are needed to assess whether these simplified algorithms are also applicable to older Asian adults with functional and/or cognitive impairment, as well as nursing home residents.

Background

According to Korea's 2019 statistics, the population of elderly individuals, aged 65 years and older, accounts for 14.9% of the total Korean population; this proportion is expected to increase to 43.9% by 2060, reaching the highest level of a super-aged society [1]. With the aging of society, interest in geriatric diseases has been increasing; in particular, interest in the prevention of and intervention for sarcopenia, which is known as an important risk factor for geriatric syndromes, has escalated [2]. Sarcopenia involves deterioration of skeletal muscle tissue with age and is one of the most important causes of functional decline and loss of independence in older adults [3], increasing the risk of functional degradation, fall, hospitalization, and mortality [4]. There is consequently a need for active prevention and management of sarcopenia in community-dwelling older adults.

A systematic review has reported that the estimated prevalence of sarcopenia varies from 9.9–40.4%, depending on the definition used [5]. These differences in prevalence also exist across populations even when using the same definition. The prevalence of sarcopenia was 63% in 249 patients in long-term care facilities in Spain, based on the first published algorithms of the European Working Group on Sarcopenia in Older People (EWGSOP) [4]. In addition, Chinese studies showed that 19.31% of 4,500 community-dwelling individuals > 50 years old (mean age 62.4 ± 8.3 years) had sarcopenia, based on the Asian Working Group for Sarcopenia (AWGS) algorithm [6]. As such, the prevalence of sarcopenia varied according to the criteria used and the race investigated. However, sarcopenia diagnosis remains challenging, because there is no simple and rapid diagnostic standard suitable for use in community-dwelling elderly.

Baumgartner et al. [7], who first defined sarcopenia, presented it as only a reduction in muscle mass. In 2010, the EWGSOP, the International Working Group on Sarcopenia (IWGS), and the AWGS presented a diagnostic algorithm for sarcopenia that included three types of gait speed (GS), hand grip strength (HGS), and muscle mass. However, the cut-off points of the diagnostic criteria of the EWGSOP and the AWGS among the sarcopenia diagnostic algorithms differ. Although diagnostic criteria based on GS used the same cut-off points, the thresholds for HGS and muscle mass differed [3]. In fact, the HGS in Asians is 25% lower than in whites, and is 27% lower in women than in men, because Asians have a relatively slender body shape compared to Westerners, and sarcopenia in Asians involves a relatively small muscle mass[3]. Therefore, there is a need to develop diagnostic criteria for sarcopenia that is suitable for Asians, and particularly for community-dwelling older adults in Korea.

Two simplified algorithms [4], based on the AWGS criteria [3], have been reported. These simplified algorithms allow rapid diagnosis, do not have a significant impact on the existing prevalence rate, and do not require measurement of GS, as GS assessment may not affect the diagnostic outcome [8, 9]. Originally, GS was included in the AWGS algorithm because it was considered the simplest and most reliable way to diagnose sarcopenia. However, among hospitalized and community-dwelling residents, there are many older adults who cannot walk well, and the risk of falls is very high due to space restrictions during measurement of GS. These simplified algorithms would thus be a suitable tool for assessing sarcopenia in Asian community-dwelling older adults, but they have not yet been validated to date.

Therefore, this study sought to investigate the prevalence of sarcopenia in Korean community-dwelling older adults by means of these algorithms. Concurrently, the prevalence of sarcopenia using the two simplified algorithms, without GS, and that determined using the AWGS-recommended algorithm, including GS, were compared, to evaluate the necessity of including GS when screening for sarcopenia.

Methods

Study design and participants' recruitment

We recruited community-dwelling older adults via an advertisement at a community centre and a clinic located in the Hamyang, a rural area in Korea. The inclusion criteria were adults aged over 60 years, who lived in the community, and were able to walk independently. The exclusion criteria were verified frailty status, such as wearing a pacemaker, having severe cardiac, pulmonary, or musculoskeletal disorders, or having severe cognitive impairment. Data were collected through questionnaires and physical measurements from October 2019 to March 2020. Of the 400 participants, 12 of these were excluded from this study due to missing data, so we collected and analysed data for 388. Trained clinical research assistants visited all the participants in person and collected the data. The clinical research assistant recorded sociodemographic characteristics, such as sex and age, and clinical data, such as the use of walking aids, if any, and cognitive function, using a general questionnaire. Cognitive function was measured using the Korean version of the mini-mental state examination (MMSE-K) [10], older adults with severe cognitive impairment were screened. The anthropometric variables of all participants were checked. Height was measured with a portable extensometer (InLab550; Biospace Co., Ltd., Seoul, Korea), which measures the length through an ultrasonic sensor. Height was measured to the nearest 0.5 cm and weight was measured to the nearest 0.1 kg. Body mass index (BMI) was calculated as the ratio of the weight to the height squared (kg/m^2).

This study was approved by the Ethics Committee of the Gyeongsang National University and written informed consent was obtained from each participant.

Data collection

In this study, an indicator that can indirectly measure sarcopenia defined by the AWGS was chosen as variables. Muscle strength was measured by HGS, physical performance was measured by GS, and muscle mass was measured by the skeletal muscle mass index (SMI).

Hand grip strength

HGS was measured with a CAMRY hand grip dynamometer (CAMRY EH101; Henqi, Guangdong, China). Participants were instructed to squeeze the dynamometer as hard as they could. HGS of the dominant hand was measured twice and the highest value was used for the analysis [11]. Muscle strength was considered low when HGS was < 26 kg in men, and < 18 kg in women.

Gait speed

Physical performance was measured using a 4-m GS test. The participants were instructed to walk a 4-meter straight course marked on the floor. There were no obstacles and the participants were instructed to walk at their usual pace. They could use a walking aid, such as a cane, if necessary. Participants were given two opportunities to perform this test. The raw score was recorded as the number of seconds required to walk 4 m in each of the two tests, and the better GS was used for scoring. The cut-off value for GS for diagnosing sarcopenia was < 0.8 m/s in men and women.

Skeletal muscle mass index

To determine the SMI, bioelectrical resistance was obtained using an InBody 720 (Biospace Co., Ltd, Seoul, Korea) at frequencies of 5, 50, 250, and 500 kHz. The principle of bio-electrical impedance analysis (BIA) is a method of measuring body composition via the detected electrical resistance, by passing a very weak current through the body and measuring skeletal muscle mass and body fat mass. This device uses eight tactile electrodes, four in contact with the palm and thumb of both hands, and four in contact with the anterior and posterior aspects of the soles of both feet. The participant stands on the soles of their feet, in contact with the foot electrodes, and grips the hand electrodes with both hands. SMI was calculated by dividing the skeletal muscle mass by the square of the height (kg/m^2) and low muscle mass was defined as an SMI < 7.0 kg/m^2 in men and < 5.7 kg/m^2 in women.

Definitions of AWGS sarcopenia: Sarcopenia was defined according to the AWGS [3]. The AWGS definition of sarcopenia, combines low muscle mass and low muscle strength, and/or physical performance: HGS < 26 kg in men, < 18 kg in women and/or GS < 0.8 m/s, SMI < 7.0 kg/m^2 in men, and < 5.7 kg/m^2 in women.

Definitions of simplified Algorithm A and B (with no gait speed measure): Algorithm A first considers the muscle strength and then, when this is low, the muscle mass [12], while algorithm B first considers the muscle mass and then, if this low, the muscle strength [9]. When both are applied, subjects with low muscle mass and strength are considered sarcopenic. All three algorithms employ the same methods to measure muscle mass and strength, only differing in the presence or absence of a gait speed component.

Statistical analysis

Demographic characteristics of the community-dwelling older adults were analysed by frequency, percentage, mean, and standard deviation (SD), according to sex. The means with SD were calculated for continuous variables and the frequencies were calculated as percentages for categorical variables.

Verification of algorithms A and B was performed as follows. First, the difference between the three algorithms were identified using the chi-square test and the prevalence of sarcopenia according to each algorithm was calculated. In addition, the specificity and sensitivity of algorithms A and B were confirmed. Statistical analyses were performed using IBM SPSS software (IBM SPSS Inc., Chicago, IL), and $p < .05$ was considered statistically significant.

Results

The study included 388 community-dwelling older adults (254 women and 134 men) with a mean ± SD age of 77.8 ± 6.26 years (range, 65−93 years) and a mean MMSE score of 19.34 points. Characteristics of the participants are reported in Table 1. Low muscle strength was present in 93.0%, low GS in 22.4%, and low muscle mass in 41.2%.

Table 1
Characteristics of participants

Variables	Total (N = 388)	Women (n = 254)	Men (n = 134)
Age	77.80 ± 6.26	78.17 ± 6.00	77.09 ± 6.69
Weight	56.33 ± 10.50	52.89 ± 8.59	62.86 ± 10.71
Height	155.27 ± 9.97	150.43 ± 8.08	164.43 ± 6.05
SMI			
<7.0 or 5.7 kg/▯ (men or women)	160 (41.2)	106 (41.7)	54 (40.3)
≥ 7.0 or 5.7 kg/▯ (men or women)	228 (58.8)	148 (58.3)	80 (59.7)
Grip strength			
< 28 or 18 kg (men or women)	361 (93.0)	227 (89.4)	134 (100)
≥ 28 or 18 kg (men or women)	27 (7.0)	27 (10.6)	0 (0)
Gait speed			
≤ 0.8 m/s	87 (22.4)	42 (16.5)	45 (33.6)
> 0.8 m/s	301 (77.6)	212 (83.5)	89 (66.4)
MMSE-K	19.34 ± 4.10	19.42 ± 3.86	19.15 ± 4.55

Values are mean ± standard deviation or n (%). MMSE-K, Korean version of Mini-Mental State Examination; SMI, skeletal muscle index.

[insert Table 1 about here]

We also calculated the prevalence of sarcopenia using the muscle mass and strength algorithm, and compared the prevalence of sarcopenia determined using the algorithm including GS. No significant difference was found (p = .223) between the prevalence of sarcopenia estimated with the AWGS-recommended algorithm (39.2%) (Fig. 1) and that estimated by algorithms A (37.6%) or B (37.6%) (Figs. 2 and 3). Of the 388 subjects, 137 participants were classified as sarcopenia by all three methods. In addition, the sensitivity of algorithms A and B was 93.8% and the specificity was 90.1%.

[insert Fig. 1 about here]

[insert Fig. 2 about here]

[insert Fig. 3 about here]

Discussion

This study was conducted to diagnose sarcopenia of the community-dwelling older adults in the rural areas of Korea, and to verify the effectiveness of using two simplified sarcopenia diagnosis algorithms based on the AWGS-recommended algorithm.

Prevalence of sarcopenia according to the AWGS algorithm

In this study, the prevalence of sarcopenia, as defined by the AWGS-recommended algorithm, in Korean rural community-dwelling older adults (mean age 77.80 ± 6.26 years) was 41.2% overall (41.7% in men, 40.3% in women). The prevalence of sarcopenia among community-dwelling older adults (770 men and 1,000 women, aged > 65 years) surveyed using the 2010−2011 Korean National Health and Nutrition Examination Survey was 6.6% in men and 9.4% in women [13]. In that study, sarcopenia was diagnosed based on a value derived by dividing the appendicular skeletal muscle mass (ASM), determined by dual-energy X-ray absorptiometry (DEXA), by weight, multiplied by 100.

In general, muscle mass is measured by DEXA, computed tomography, magnetic resonance imaging, and BIA. BIA is evaluated by dividing the ASM by the square of the height [7] or by weight and multiplying by 100 [14]. BIA is widely used because it is a safe and cost-effective method that avoids radiation exposure and measures body composition [15]. In our study, muscle mass was calculated by dividing ASM by height squared, and muscle mass, muscle strength, and muscle function were all considered when diagnosing sarcopenia. Thus, an accurate comparison of the two studies is difficult because the muscle mass measurement method and the variables for diagnosing sarcopenia were applied differently.

Since muscle mass does not correlate positively with muscle function, muscle strength and physical function were also measured, unlike in previous studies when sarcopenia was diagnosed only by measuring muscle mass [16]. For accurate comparisons, we searched for studies from other countries in Asia that applied the same measurement variables and cut-off values (HGS < 26 kg in men, < 18 kg in women, GS < 0.8 m/s, and/or SMI < 7.0 kg/m^2 in men, < 5.7 kg/m^2 in women) used in this study. The prevalence of sarcopenia in 1,076 community-dwelling older adults in China aged over 60 years (mean age 67.29 ± 6.0 years) was 9.3% in men, 6.4% in women, and 11.5% overall [17]. In another study from China, the prevalence of sarcopenia in 4,500 community-dwelling older adults over the age of 50 years (mean age 62.4 ± 8.3 years) in four regions was 19.31% [6]. In Japan, the prevalence of sarcopenia among 959 community-dwelling older adults (aged 60 years and older) was 9.6% in men and 7.7% in women, [18]. Previous studies on the prevalence of sarcopenia in community-dwelling older adults using the AWGS-recommended algorithm have reported values ranging from 9.3−19.31% [6, 17, 18].

Although the AWGS algorithm had a high sensitivity and validity, the reason for the higher prevalence in this study as compared to previous studies was probably the difference in demographic characteristics. The mean age of the subjects in the study of Han et al. [17] was 67.29 ± 6.0 years, while it was 62.4 ± 8.3 years in the study of Liu et al. [6]. The mean age of the subjects in this study was 77.80 ± 6.26 years, which was slightly older than that in the other two studies. The prevalence of sarcopenia increases significantly with age in both men and women [19]. In fact, according to Kim et al. [13], adults aged 70−

74 years were at 4.10-fold higher risk of sarcopenia than those aged 65–69 years, and those aged 75–79 years were at 3.15-fold higher risk of sarcopenia than those 65–69 years old, supporting the results of this study.

Hamyang-gun, the area in which data were collected in this study, is a rural area, with individuals aged 60 years and over accounting for 42.5% of the population [20]. A previous study using the AWGS algorithm found a prevalence of sarcopenia among older adults in rural and urban areas of 13.1% and 7.0%, respectively, and multiple logistic regression revealed that rural residence was an independent risk factor for sarcopenia [21]. This means that the old adult in rural areas can have different clinical characteristics compared to cities [21], in future, further studies are needed to determine the prevalence of sarcopenia by focusing on the older adults in rural areas.

Validation of simplified algorithms for sarcopenia diagnosis

The most widely used tools for diagnosing sarcopenia in communities is the AWGS-recommended algorithm, and BIA, hand grip dynamics, and GS are considered the most effective, reliable, and viable technology for measuring algorithmic variables in Asia [3].

No significant difference was found (p = .223) between the sarcopenia prevalence determined using the AWGS-recommended algorithm (39.2%) and that estimated using algorithms A (37.6%) or B (37.6%), validating the use of these two simplified algorithms for sarcopenia diagnosis in this type of population. With algorithm A, the muscle strength is measured first, and muscle mass only needs to be assessed in women with muscle strength below 18 kg and in men with strength below 26 kg. However, 93% of the present participants had a muscle strength below these cut-off values; therefore, it was necessary to measure the muscle mass in almost all cases. Conversely, muscle mass is measured first in algorithm B, and muscle strength only needs to be assessed in individuals with low muscle mass (SMI < 5.7 kg/m^2 in women and < 7.0 kg/m^2 in men). This proved to be an advantage in the present population, because the muscle mass measurement alone sufficed to rule out sarcopenia in 288 (59%) of the participants.

Many previous studies have excluded individuals who could not walk or had cognitive impairment, which limited the representativeness of the results [22–26]. The use of GS for the diagnosis of sarcopenia is problematic, and can lead to some degree of error in diagnosis [8]. Omitting GS in algorithms A and B makes it quick and easy to diagnose sarcopenia in older community-dwelling people with marked limitations, particularly those who are not walking well, as suggested by Yoshida et al. [12] assumed.

Study limitations

The study was conducted with a limited number of participants, all of whom were rural community-dwelling older adults in Korea; thus, our findings may have limited generalizability. However, in this study, it was verified that the diagnosis of muscle sarcopenia can be easily performed by measuring muscle mass using a BIA device, without using X-ray imaging with a wide range of measurements being limited. BIA devices are very sensitive to changes in moisture conditions and can overestimate fat levels, but many studies [27–29] have found that this is a reasonable, reliable, and feasible way to evaluate muscle

mass when diagnosing myasthenia. In addition, this study focused on adults dwelling in a single rural area in Korea; in future, it will be necessary to conduct additional research to confirm the validity of algorithms for the elderly living in various regions.

Conclusion

By using a questionnaire and physical measurements, this study sought to identify the prevalence of sarcopenia in community-dwelling Korean older adults, and concurrently to validate the use of the simplified algorithms A and B for diagnosing sarcopenia. The overall prevalence of sarcopenia as determined by the AWGS-recommended algorithm and simplified algorithms A and B was highly similar (39.2%, 37.6% and 37.6%, respectively). Thus, we have confirmed that the simplified algorithms are suitable for diagnosing sarcopenia in community-dwelling elderly individuals residing in rural Korea. The data obtained may serve as a basis for developing a simpler and more reliable diagnosis of sarcopenia in older adults with functional and/or cognitive impairment, as well as in nursing home residents.

Abbreviations

ASM
Appendicular skeletal muscle mass
AWGS
Asian Working Group for Sarcopenia
BIA
Bio-electrical impedance analysis
BMI
Body mass index
CT
Computed tomography
DEXA
Dual-energy X-ray absorptiometry
EWGSOP
European Working Group on Sarcopenia in Older People
GS
GS
HGS
Hand grip strength
IWGS
International Working Group on Sarcopenia
KNHANES
Korean National Health and Nutrition Examination Survey
MMSE-K

Korean version of Mini-Mental State Examination
MRI
Magnetic resonance imaging
SD
Standard deviation
SMI
Skeletal muscle mass index

Declarations

Acknowledgements

We thank all the participants for the time dedicated to this study.

Competing interests

The authors declare that they have no competing interests.

Funding

Availability of data and materials

The data that support the findings of this study are available from the corresponding author on request.

Authors' contribution

MK and HKC were responsible for the study design and performed the data collection. HKC, JYL, and CRG performed the data analysis, and were responsible for drafting of the manuscript. HKC supervised the study and HKC and JYL provided statistical expertise. All authors have read and approved the current version of the manuscript.

Ethics approval and consent to participate

We received ethical approval for the study from the Institute of Review Board at Gyeongsang National University (Approval No. GIRB-A19-Y-0080); all participants were informed of the objectives, methods, and procedures of data collection. Their rights to confidentiality, anonymity, and voluntary withdrawal from study participation were explained and assured, as was the disposal of material containing personal information after the completion of the study. Written informed consent to participate was obtained from all participants.

Consent for publication

Not applicable.

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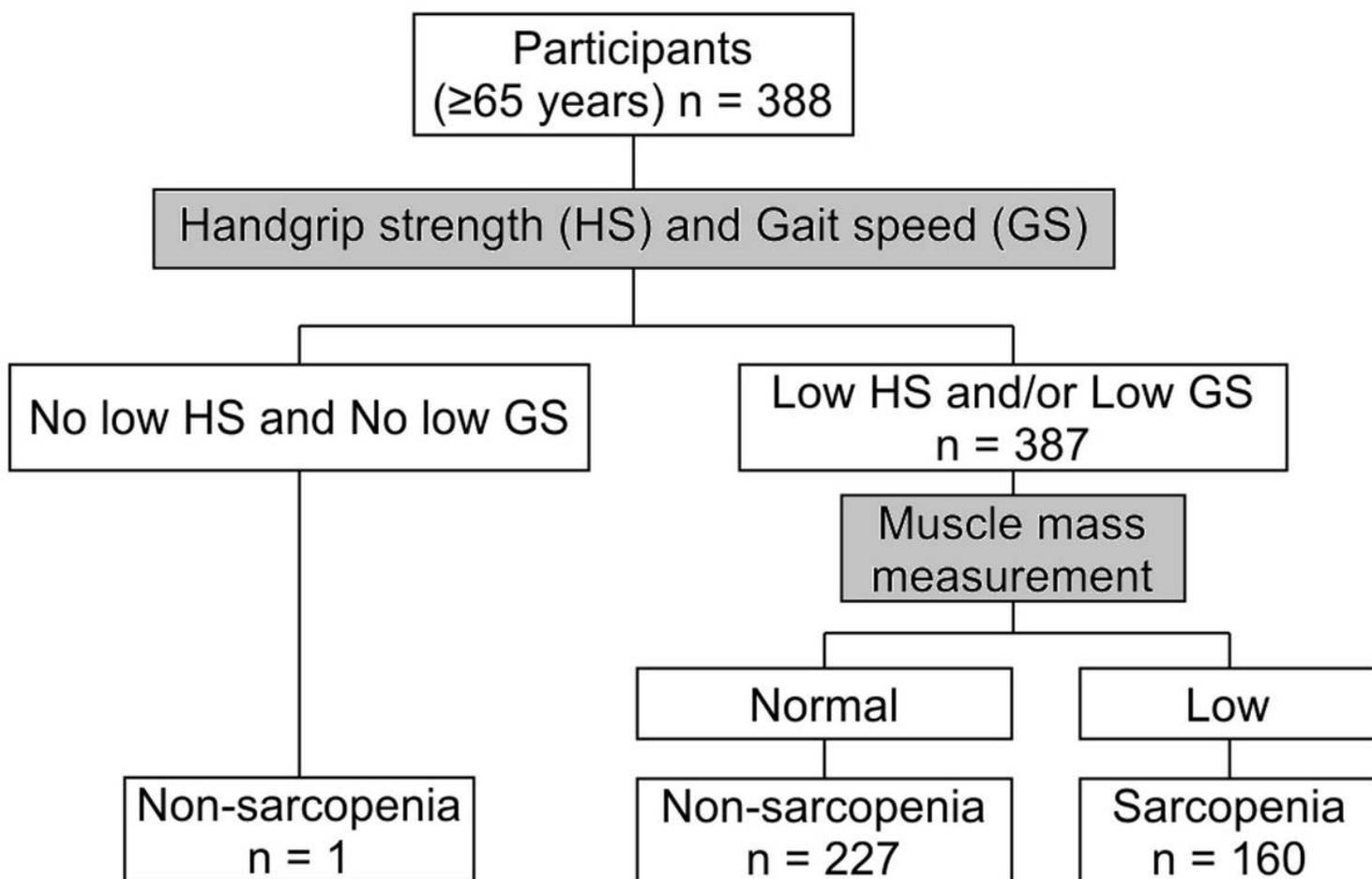
Figures

Figure 1. Assessment of the prevalence of sarcopenia in community-dwelling older Korean adults according to the AWGS-recommended algorithm.
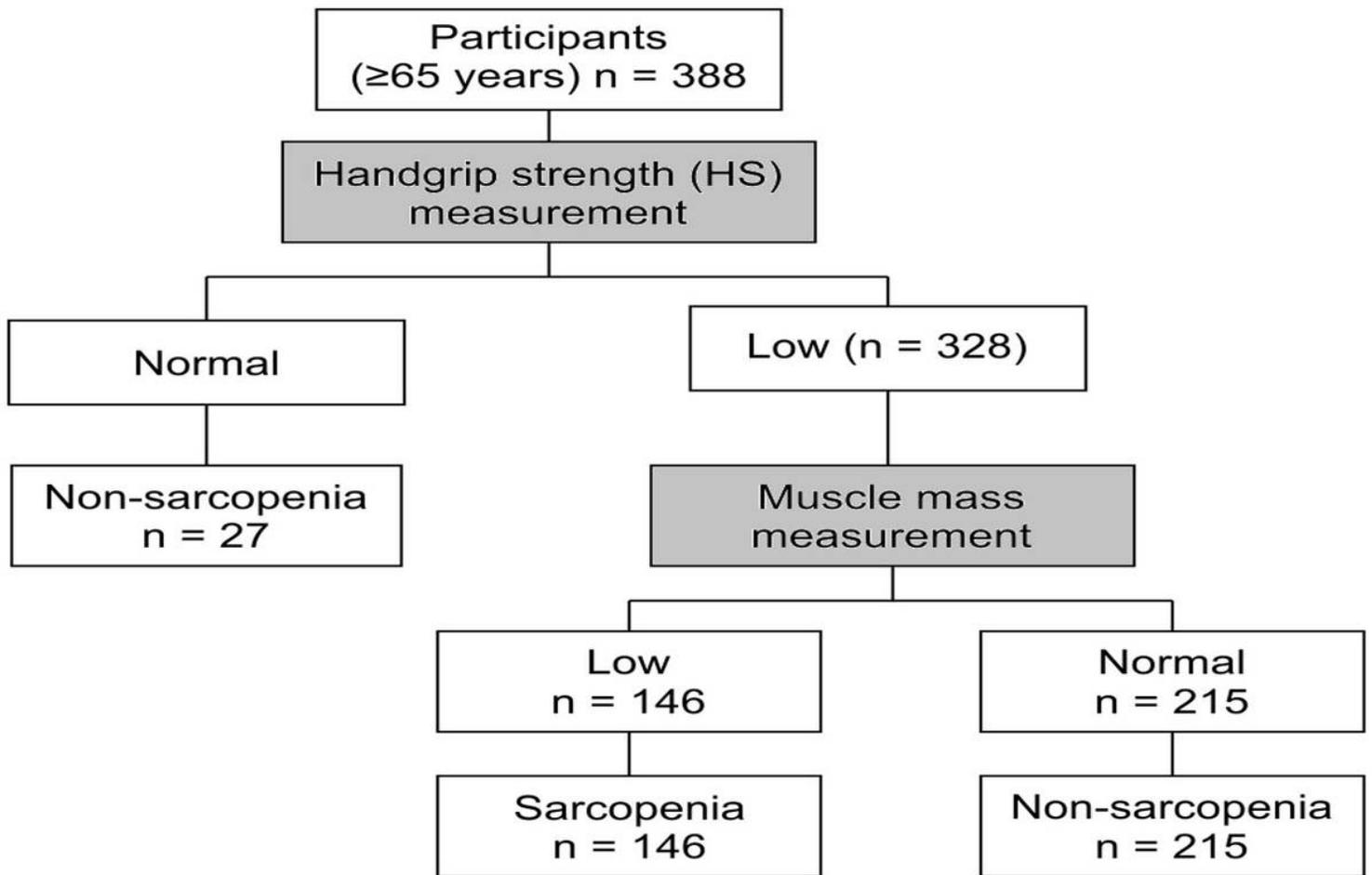
Figure 1

Figure 1

Figure 2. Assessment of the prevalence of sarcopenia in community-dwelling older Korean adults according to algorithm A, based on muscle strength and muscle mass.
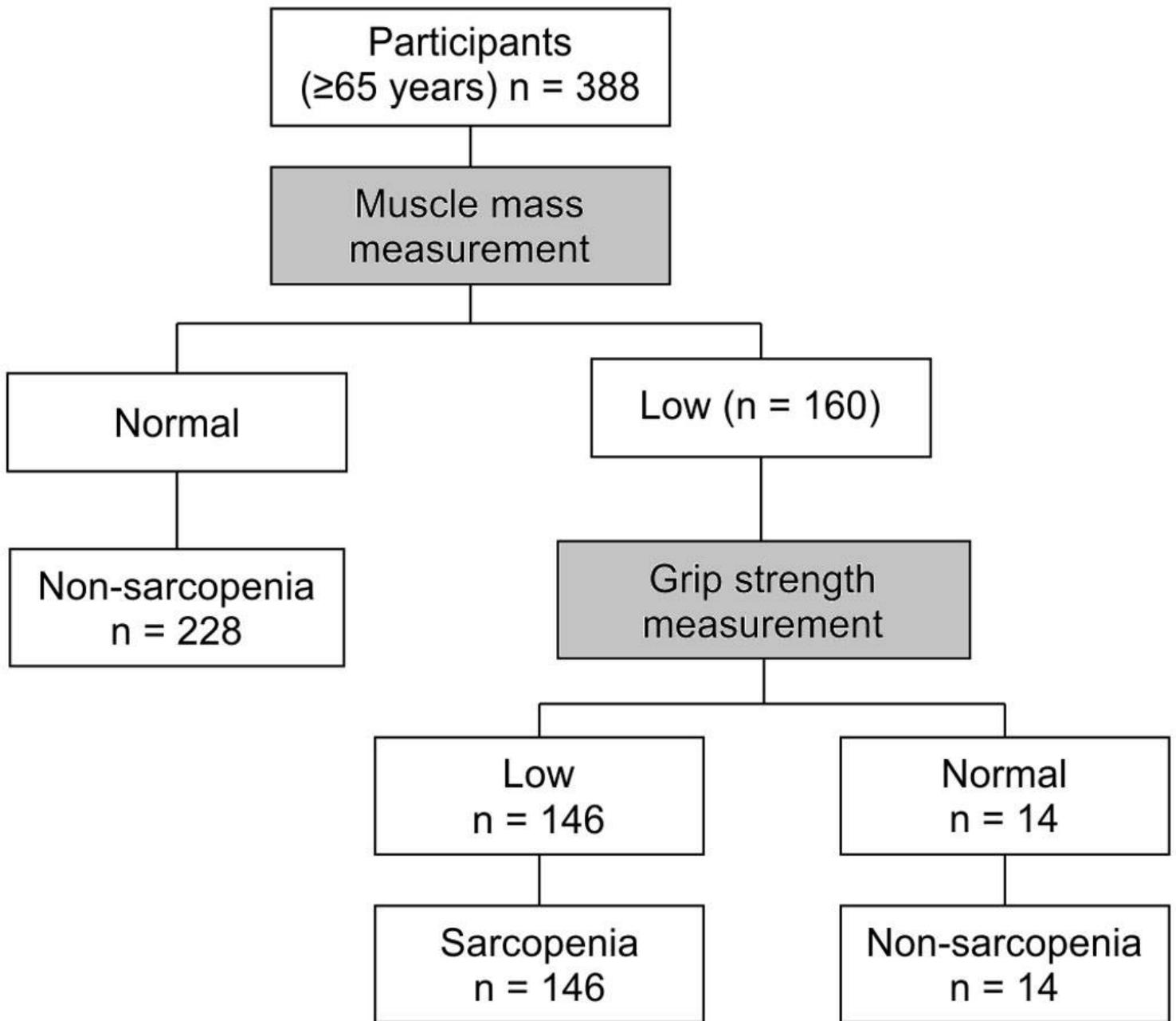
Figure 2

Figure 2

Figure 3. Assessment of the prevalence of sarcopenia in community-dwelling older Korean adults according to algorithm B, based on muscle mass and muscle strength.

Figure 3

Figure 3

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