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Difference in Sarcopenia Prevalence according to the Update of Diagnostic Algorithm in Korean Population

한국인 집단에서 진단 기준 변경에 따른 근감소증 유병률 차이

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Abstract

Difference in Sarcopenia Prevalence according to the Update of Diagnostic Algorithm in Korean Population

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Introduction: Sarcopenia is a disease characterized by deterioration of physical performance and muscle strength as the skeletal muscle mass decreases with aging. This reduces quality of life, triggers the progression of chronic diseases such as diabetes, obesity, cardiovascular disease, and osteoporosis, and increases mortality and health care costs. However, because of the diversity and complexity of diagnostic algorithms, It has not yet been well applied to the clinical situation. The European Working Group on Sarcopenia in Older People (EWGSOP) and Asian Working Group for Sarcopenia (AWGS) have recently updated their diagnostic criteria, which will lead to changes in the prevalence and distribution of diagnosis.

Methods: The data of three different studies, Seoul National University Frailty Intervention (SNUFI) cohort, Gait Protocol Study and Sunchang Exercise Intervention Study, were collected retrospectively. 221 participant's data were reviewed and data from 191 community-dwelling older adults were reviewed. The data are presented as mean (± SD) for continuous variables and as numbers (percentages) for categorical variables, and the Cohen's kappa coefficient was used to evaluate the degree of agreement between guidelines.

Results: There was no significant difference in the prevalence of sarcopenia using each guidelines with same regional muscle mass criteria. The prevalence using EWGSOP 1 and 2 were 14% and 10%, respectively, and 10% and 13%, respectively, when using AWGS 1 and 2. The Cohen's kappa coefficient between each guideline was high, ranging from 0.744 to 0.887.

Conclusion: The prevalence using EWGSOP2 guideline is similar with those using other guidelines including AWGS2 is similar, from 10% to 14%, in Korean population when using same regional muscle mass criteria. The degree of agreement between diagnostic guideline is also high, indicating that similar patients are diagnosed despite major changes of EWGSOP2.

Keywords: Sarcopenia, Muscle strength, Muscle mass, Physical performance, Diagnostic algorithm, Prevalence

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I. Introduction

Sarcopenia is a disease characterized by deterioration of physical performance along with muscle strength as the skeletal muscle mass decreases with aging. [1-6] As age increases, muscle mass decreases by 10-15% at 50-70 years old and more than 30% at 70-80 years, thereby causing a decrease in muscle strength and muscle function. [7] The deterioration of physical performance increases the risk of falls and hip fractures, thereby reducing quality of life, and increasing the risk of death. [8-10]

Sarcopenia can also cause progression of chronic diseases such as diabetes, obesity, cardiovascular disease, and osteoporosis. [11-13] This causes a decrease in basal metabolic rate, which increases insulin resistance and promotes the occurrence of type 2 diabetes, and insulin resistance and diabetes create a vicious cycle that worsens sarcopenia. [11] It also causes high blood pressure and increases mortality by increasing the risk of cardiovascular disease by 3-5 times. [14-16]

Accordingly, the time spent in hospitals for the elderly becomes longer, and therefore, 10 out of 80 years of total lifespan becomes the 'period of inability to do daily activities due to illness'. which is a major factor causing an increase in healthcare costs in an aging society. [8, 16] Several studies show this very well, that those with sarcopenia at hospitalization had hospital costs more than five times higher than those without sarcopenia. [17] A large community-based study conducted in the Czech Republic found that for older people with sarcopenia, the cost of direct medical care was more than twice as high as for those who did not. [18]

For this reason, sarcopenia is recently recognized as an important health care field, and various researches are being conducted accordingly, and also has been officially classified as a muscle disease with an ICD-diagnosis code.[19-21] Nevertheless, sarcopenia is not yet applied in clinical situation, because the diagnosis algorithm is diverse and complex, the cutoff value is not unified, and the method of measuring muscle mass and quality is not clear.[2] This is because the definition of sarcopenia diagnosis is essentially an operational definition, that new findings can always challenge current understanding.[4]

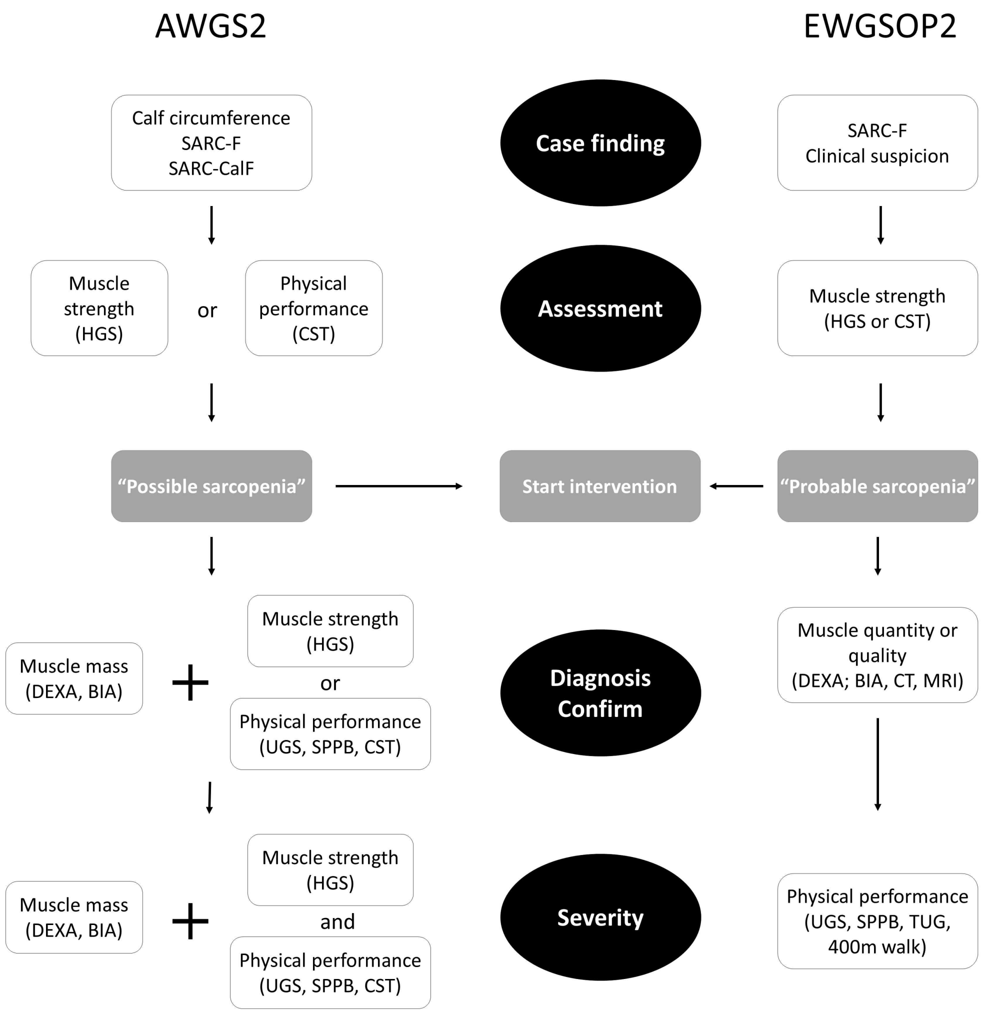
In the guideline of European Working Group on Sarcopenia in Older People(EWGSOP1), published in 2010, sarcopenia was classified into three categories based on a decrease in muscle mass, muscle strength and physical performance.[1] They classified a decrease in muscle mass but normal muscle strength and physical activity as presarcopenia, a decrease in muscle mass and either muscle strength or physical activity as sarcopenia, and a case in which both muscle strength and physical activity decreased as severe sarcopenia. This has become the basic frame of diagnostic algorithm followed by many guidelines.

The Asian Working Group for Sarcopenia released its first guideline(AWGS1) in 2014.[3] Even though the approaching method for diagnostic algorithm were similar to the EWGSOP1, the cutoff values have been partially adjusted due to the differences between Asian and Caucasian populations, such as ethnicities, body size, lifestyles, and cultural backgrounds. AWGS1 also recommended that screening tests should include measuring both muscle strength and physical performance.

In 2019, AWGS and EWGSOP both updated their guidelines, and AWGS2 has been revised in a way that maintains the basic frame, partially modifying the cutoff value and directing specific guidelines for each method of measurements.[4] Characteristically, AWGS2 introduced the concept of "possible sarcopenia", which is diagnosed with low muscle strength regardless of whether or not the body function is decreased. It was developed for primary health care and preventive services, to encourage early lifestyle interventions and provide related health education. (Figure 1)

On the other hand, EWGSOP2 made a major change that strength comes to the forefront, to fill the gaps for research and clinical practice.[2] This is because it is recognized that muscle strength is better than muscle mass when predicting healthcare outcomes, and due to technical limitations, muscle mass are still problematic to be measured as the main parameter. [22, 23] Accordingly, if muscle strength is low, it is classified as probable sarcopenia, similar to possible sarcopenia of AWGS2, and that intervention is recommended to start in the clinical setting. Unlike before, physical performance is used as a tool to evaluate only severity, and if it is less than cutoff, it is classified as severe sarcopenia. (Figure 1)

Figure 1. Case finding Algorithm of AWGS2 (for primary health care setting) & EWGSOP2 guideline



The evaluation techniques and cutoff values of variables such as mass, strength and physical performance have also changed in a great variety. Choosing which evaluation techniques to apply involves considering how accurately they reflect the current state of the individuals and how they change over time in same individuals. In addition, cost and availability are also important factors to consider. It is also difficult to determine the cutoff value. Ideally, it should be determined through a longitudinal outcome-based study, but in a state where sufficient research is not actually conducted, the normative value is estimated and used through an epidemiology study. [24]

Muscle mass

Several techniques can be used for evaluation of muscle mass. [25] EWGSOP1 introduced several methods, including several imaging techniques, and described that computed tomography (CT) and magnetic resonance imaging (MRI) can measure them most accurately and are close to the gold standard. However, considering the cost and availability, Dual-energy X-ray absorptiometry (DEXA) is the most preferred in clinical situations, and that Bioelectrical impedance analysis (BIA) can be a good substitute for portable situation. Several studies were mentioned for the cutoff value with DEXA, but the "Rosetta study", which set appendicular skeletal muscle mass (ASM) with height squared as the skeletal muscle mass index, and 2 standard deviation (SD) below the average of young adults as a cutoff, was most cited. [26, 27] The suggested cutoff values were 7.26 kg/m^2 in men and 5.55 kg/m^2 in women.

In the newly updated EWGSOP2, DEXA was also preferred, and the cut off with ASM/height^2 was set to 7.0 kg/m^2 in men and 5.5 kg/m^2 in women based on the Gould et al' study.[2, 28] Also, based on Studenski et al's study, the cut off with ASM were set to 20 kg in men and 15 kg in women.[29]

Unlike EWGSOP, AWGS supports the use of BIA for muscle mass evaluation due to its portability and reasonable cost.[3, 4] For cutoff value determination, AWGS also recommends using 2SD below the mean of young reference group, and so the suggested values were 7.0 kg/m^2 in men and 5.7 kg/m^2 in women by using BIA (with ASM/height^2). By using DEXA (with ASM/height^2), 7.0 kg/m^2 in men and 5.4 kg/m^2 were the suggested cutoff value.

Muscle strength

In the evaluation of muscle strength, only handgrip strength (HGS) is used in clinical setting because of its cost, availability, ease of use, and its association with leg strength.[23, 30, 31] Although the lower limbs are more related to gait and body function than the upper limbs, measurement techniques for lower limb strength, such as measuring knee extension strength, needs some special equipment and training.[32] On the other hand, HGS can be measured easily with a simple instrument called a handheld dynamometer and is well related to clinical outcomes.[33, 34] So, the EWGSOP1 recommended the HGS for diagnosis of sarcopenia and set <30 kg for men and <20 kg for women as a cutoff value.[34]

AWGS also recommended the HGS, and because of the lack of outcome-based cutoff values, AWGS1 recommended the cutoff value as the lower 20th percentile of the study population before outcome-based data is available.[35] The suggested cutoff values were <26 kg for men and <18kg for women. Analyzing data from an 8 Asian cohort of 21,984 participants over the age of 65, AWGS2 altered the HGS cutoff of <28.0 kg for men and <18.0 kg for women.[36]

On EWGSOP2, the cutoff of HGS were set to 27 kg in men and 16 kg in women, based on Dodds et al's study.[37] And, unlike other guidelines, they recommended the chair stand test (also called chair rise test) for measurement of lower limb strength.[2] The chair stand test measures the time required for a patient to get up five times from a sitting position without using his arms. Since the chair stand test requires both strength and durability, EWGSOP2 has chosen this test as a convenient and qualifying measure for lower limb. If it takes more than 15 seconds, the clinician can determine that there is a decrease in strength. [38]

Physical performance

A wide range of techniques can be used to assess physical performance, including usual gait speed (UGS), the Short Physical Performance Battery (SPPB), the timed up and go test (TUG) and the 6-min walking test.

UGS is widely used in clinical practice, considered a quick, safe and highly reliable test. [81-E2]. Protocols for measuring UGS had diverse methodologies, that the following should be determined; starting method (moving or static), walking distance (4m, 6m, or 10m), number of repetition, usual or fastest speed, average or maximal speed. Both EWGSOP1 and 2, and also AWGS1, set the cutoff of UGS as 0.8 m/s, but AWGS2 increased the cutoff to 1.0 m/s.[34, 35, 39, 40]

The SPPB is also widely used in clinical setting, consists of three tests: static balance, gait speed and chair stand. Each test is weighted equally with scores between 0 and 4. Static balance is examined by measuring the time to stand in side-by-side, semi-tandem and tandem positions. Gait speed is measured on 4 m with static start. Chair stand test is to measure the time to rise from a chair and return to the seated position five times.[41] Both EWGSOP1 and 2 set the cutoff as score 8. [1, 2] AWGS1 did not include SPPB in the guideline, but was added with cutoff set to score 9 in AWGS2, because SPPB score of 9 was more predictive of mortality an SPPB score of 9 is more predictive of mortality. [3, 4, 42]

TUG is a test for assessment of mobility, balance, walking ability, and fall risk, consists of the subject to stand up from a chair, walk a short distance, turn around, return and sit down again. EWGSOP1 considered it as possible evaluation tool, and EWGSOP2 included it as cutoff of 20 seconds as a diagnostic criterion. [1, 2, 43] However, AWGS excluded TUG, because abnormal results can be caused by a wide variety of underlying conditions. [3]

Instead, AWGS2 included chair stand test, which is part of SPPB and is included for strength measurement in EWGSOP2. Based on Nishimura et al's study, CST cutoff is set to 12 seconds which is corresponded to a walking speed of 1.0 m/s.[44]

The recommended measurement method and cutoff value of each guidelines is summarized on table 1.

Table 1. Recommended measurement method and cutoff value of each guidelines.

Measurement variable	Method	EWGSOP1	AWGS1	EWGSOP2	AWGS2
Muscle mass	DEXA	ASM/height^2 (kg/m^2) Men : <7.26 Women : <5.55	ASM/height^2 (kg/m^2) Men : <7.0 Women : <5.4	ASM/height^2 (kg/m^2) Men : <7.0 Women : <5.5 ASM Men : 20 kg Women : 15 kg	ASM/height^2 (kg/m^2) Men : <7.0 Women : <5.4
	BIA		ASM/height^2 (kg/m^2) Men : <7.0 Women : <5.7		ASM/height^2 (kg/m^2) Men : <7.0 Women : <5.7
Muscle strength	Handgrip strength	Men : <30 kg Women : <20 kg	Men : <26 kg Women : <18 kg	Men : <27 kg Women : <16 kg	Men : <28 kg Women : <18 kg
	CST			≥15 s	
Physical performance	Gait speed	≤0.8 m/s	≤0.8 m/s	≤0.8 m/s	<1 m/s
	SPPB	≤8		≤8	≤9
	TUG			≥20 s	
	CST				≥12s

Therefore, the aim of this study is to determine the prevalence of sarcopenia and analyze the differences by applying EWGSOP2 guideline, which had recently undergone major changes, together with AWGS2 and previous guidelines. Comparing the criteria of EWGSOP and AWGS with the former and updated guideline in Korean population using regional thresholds of muscle mass with adjustments will provide useful information for the other sarcopenia studies.

II. Methods

1. Research participants

We analyzed the data retrospectively from 221 community-dwelling older adults, which were collected on three different studies.

The first study is Seoul National University Frailty Intervention (SNUFI) cohort which is a single-center cohort study that began in 2018 with the aim of identifying the contributing factors on sarcopenia. SNUFI cohort recruited 77 community-dwelling individuals at the department of rehabilitation, Seoul National University Hospital (SNUH). The lower age limit was 65 years, and exclusion criteria were neurological diseases (stroke or Parkinson's disease), cognitive dysfunction (Mini Mental State Examination score less than 24), people who have difficulty on communication (aphasia or hearing loss), people with musculoskeletal problems that affect physical functions (such as amputation) and critical or terminal illness (severe chronic obstructive pulmonary disease, uncompensated heart failure, uncontrolled hypertension, uncontrolled diabetes mellitus, regular corticosteroid treatment for an inflammatory condition, malignant tumors requiring treatment within the last 5 years). The medical history, body composition, muscle strength, physical performance and some questionnaires were collected every 6 months. The final analysis for this study included the data of baseline examinations of 64 participants excluding missing data.

The second study is 'Gait Protocol Study' which is a cross-sectional study to develop an optimal protocol for measuring gait speed in the elderly. It was conducted in 2019 with 84 patients recruited at Seoul National University Bundang Hospital (SNUBH) and Seoul National University Boramae Medical Center (BRMH). 65 years or older adults who are able to walk more than 100m independently were included, and exclusion criteria were established for the patient with the following characteristics: 1) Hemiplegia or paraplegia, 2) Severe apraxia, 3) NYHA classification III or more, 4) Kellgren grade III or more, 5) Myocardial infarction within 6 months, 6) History of fractures within 6 months. In addition to various types of UGS measurement, variables associated with sarcopenia such as muscle mass measured by BIA and SPPB score were collected. In this study, measurement data of 73 participants were analyzed.

The last study is Sunchang Exercise Intervention Study. The primary aim of this study was to evaluate the effects of exercise intervention program for older adults with osteoarthritis. 60 participants were recruited from Sunchang gun (Jeollanam-do, Korea) and randomized to two groups. Degenerative arthritis of knee was defined with clinical symptom and radiologic assessment, with Kallen grade ≥2. Patients with active inflammatory arthritis, contracture, neurologic comorbidities were excluded. Intervention group performed exercise intervention including resistance exercise and aerobic exercise for 3 months, and measurement variables were evaluated before and after intervention. For this study, pre-intervention evaluation data of 52 patients from both groups were used.

Details of the designs and participant recruitment of these studies have been summarized on table 2. All of the cohort studies required written informed consent, and were approved by the respective institutional review boards.

Table 2. Details of the designs and participant recruitment of included studies.

Study Name	Study Location	Study Year	Inclusion criteria	Exclusion criteria	Collected variables	Number of participants
SNUFI	SNUH	2018	1) 65 years or older 2) community dwelling 3) ambulatory with or without an assistive device	1) Neurological diseases 2) Cognitive dysfunction 3) Musculoskeletal problems 4) Critical or terminal illness	1) BIA, DEXA, ultrasonography 2) HGS, Knee extensor strength 3) 10MWT, SPPB, CST, etc. 4) MMSE, K-ADL, K-IADL, etc.	N= 77
Gait Protocol study	SNUBH BRMH	2018	1) 65 years or older 2) able to walk more than 100m independently	1) Hemiplegia or paraplegia 2) Severe apraxia 3) Kellgren grade III, IV 4) History of fractures within 6 months	1) BIA 2) HGS 3) UGS measurements, SPPB, CST 4) MMSE, K-ADL, K-IADL	N= 84
Sunchang Exercise Intervention Study	Public health care center in Sunchang	2016	1) 50 years or older 2) BMI > 24 kg/m^2 3) degenerative arthritis of knee 4) able to walk independently	1) Active inflammatory arthritis 2) Joint contracture related with severe arthritis 3) Neurological comorbidities	1) BIA 2) HGS 3) SPPB, Stair climb power test 4) BPI, WOMAC, ABC, SOF index	N= 60

2. Measurement procedure

Muscle mass

Body composition was measured using the bioelectrical impedance analysis (BIA). In all three studies, multi-frequency 8-electrode BIA analyzer (Inbody 770 for SNUFI, Inbody S10 for Gait protocol study and Sunchang Exercise Intervention Study, InBody Co. Seoul, South Korea, Figure 2) which can obtain a total of 30 impedance measurements using 6 different frequencies(1 kHz, 5 kHz, 50 kHz, 250 kHz, 500 kHz, 1000 kHz) in 5 segments (right and left arms, trunk, right and left legs), was used. The test was performed while the subjects fasted for more than 8 hours. InBody770 is designed for measurements in the standing position so the participants of SNUFI were instructed to stand on soles in contact with the foot electrodes and grab the hand electrodes. For InBody S10 in other two studies, the participants were instructed to lie on the test table in a comfortable state. These devices can automatically analyze ASM, but in Gait protocol study and Sunchang Exercise Intervention Study the ASM result was not recorded, so the estimates for ASM were used using an arithmetic expression. (ASM = Total skeletal muscle mass * 0.75)[45, 46] For the pooling analysis, we defined muscle mass cutoff points according to the AWGS guidelines (7.0 kg/m^2 in men and 5.7 kg/m^2 in women), because EWGSOP recommends to set cutoff in consideration of age, ethnicity and other related factors.[2]

Figure 2. Multi-frequency 8-electrode BIA analyzer, Inbody 770 [A] and InBody S10 [B]

[A] [B]

Muscle strength

Handgrip strength was measured using a Smedley type digital handgrip dynamometer, Takei Hand Grip Dynamometer (T.K.K.5401; Takei Scientific Instruments Co, Ltd, Tokyo, Japan, Figure 3). Participants in a sitting with 90′ elbow flexed position were instructed to hold and squeeze the handles with maximum effort for 3 seconds, encouraged by words. With 3-min rests between measurements of the same hand, SNUFI measured three times in the dominant hand, and Gait protocol study and Sunchang Exercise Intervention Study measured three times with hands alternating in both hands. The maximum handgrip strength was used and was expressed in kilograms.

Figure 3. A Smedley type digital handgrip dynamometer, Takei Hand Grip Dynamometer[A] and the Measurement posture [B]

[A] [B]

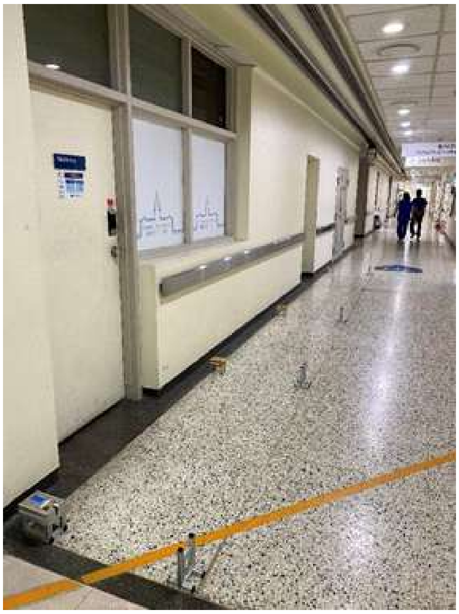
Physical performance

For usual gait speed (UGS), the starting method (moving or static), walking distance (4m, 6m, or 10m), and the number of repetitions should be determined. SNUFI used the automatic instrument (Figure 4A) and measured the UGS with 10-meter walking test (10MWT) protocol. This protocol is a test that instructs participants to walk 10m and finds obtains the speed of passing a distance of 6m among them, that is, a test that measures a speed of 6m with moving start. The test was repeated twice and the maximum speed was used for analysis. On Gait protocol study, which is a study to develop an optimal protocol for measuring gait speed, several methods for measuring UGS were conducted. In this analysis, similar method with SNUFI, except that the average speed was used, was included, which is suitable for the guideline recommended by AWGS2. In the Sunchang Exercise Intervention Study, a 4m distance walking speed was manually measured with a static start. SPPB was performed according to the protocol in all three studies with 42cm high standard chair without arm.

The measurement methods used on three studies are summarized on table 3.

Figure 4. Automatic instruments for measuring UGS on SNUFI [A] and Gait protocol study [B, Gaitspeedometer, Dynamicphysiology, Korea]

[A]



[B]

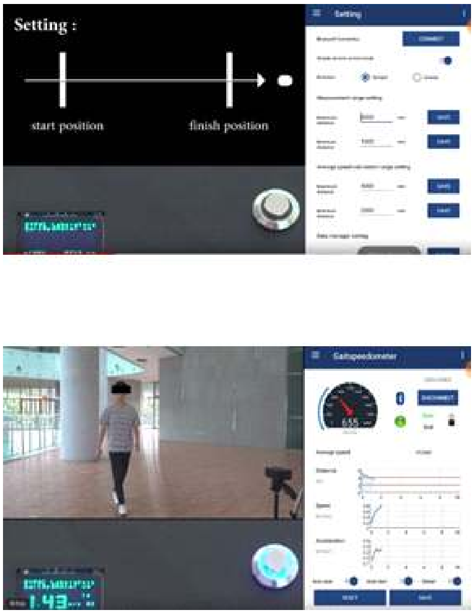


Table 3. Details of measurement technique of included studies.

Measurement Variable	Consideration	SNUFI	Gait Protocol study	Sunchang Exercise Intervention Study for Osteoarthritis
BIA	Device	Inbody 770	InBody S10	
	Posture	Standing in the foot electrodes	Lying on the test table in a comfortable state	
	Adjustment	Measured ASM	Estimated ASM = SSM * 0.75	
	Others	Fasting for more than 8 hours		
HGS	Device	Takei Hand Grip Dynamometer		
	Posture	Sitting with 90′ elbow flexed position		
	How to measure	Maximum effort for 3 seconds With 3-min rests between measurements		
	Hand	Dominant hand	Both hand	
	Adjustment	Maximum strength		
UGS	Start	Moving start	Moving start	Static start
	Measurement	Automatic instrument	Automatic instrument (Gaitspeedometer Ver.4)	Manual stopwatch
	Distance	6m	6m	4m
	N. of repetition	2	2	2
	Adjustment	Maximum	Average	Average
SPPB	Chair	42cm high standard chair without arm		

3. Statistical analyses

The data are presented as mean (± SD) for continuous variables and as numbers (percentages) for categorical variables. The Cohen's kappa coefficient was used to evaluate the degree of agreement between guidelines and unpaired Student's t-test, Mann-Whitney U test, Pearson chi-squared test, Fisher's exact test and One-way ANOVA were used as appropriate. Analyses were performed using SPSS version 19.0.

III. Results

Data of 221 participants from three studies were screened, 191 participants were included for the analysis excluding participants with missing data (n=30, 14%). Overall, the mean age was 71.4 years (± 4.9) and 65% were woman. Between men and women, there was no significant difference in age (72.2 + 4.6 for men and 71.1 + 5.0 for women) and body mass index (24.7 + 2.3 for men and 24.7 + 2.8 for women). Between three studies, there were significant difference in sex ratio, height, weight, HGS, and physical performance parameters on Sunchang Exercise Intervention Study for Osteoarthritis study. The clinical characteristics of participants are summarized in Table 4.

Table 4. Demographics and characteristics of participants.

Parameters	Overall(N=189)	SNUFI(N=64)	Gait protocol study(N=73)	Sunchang Exercise Intervention Study for Osteoarthritis (N=52)
Age (years)	71.4 (± 4.9)	72.1 (± 4.8)	70.6 (± 4.2)	71.8 (± 5.8)
Sex (M : F)	66 : 123	31 : 33	25 : 48	10 : 42
Height (cm)	156.7 (± 8.8)	159.7 (± 9.2)	158.3 (± 7.7)	150.9 (± 7.0) *
Weight (kg)	60.3 (± 9.6)	61.3 (± 10.6)	61.9 (± 8.8)	56.8 (± 8.8) *
BMI (kg/m^2)	24.7 (± 2.7)	23.9 (± 2.7)	24.6 (± 2.6)	24.9 (± 2.9)
ASM/$height^2$ (kg/m^2)	6.7 (± 1.1)	6.8 (± 1.1)	6.5 (± 0.9)	6.9 (± 1.2)
Handgrip strength (kg)	24.7 (± 7.7)	24.7 (± 8.4)	27.0 (± 7.3)	21.5 (± 6.0) *
Chair stand test (s)	12.0 (± 4.4)	11.0 (± 3.8)	9.8 (± 3.0)	16.2 (± 4.0) *
Usual gait speed (m/s)	1.3 (± 0.2)	1.3 (± 0.2)	1.4 (± 0.1)	1.1 (± 0.2) *
SPPB score	10.7 (± 1.6)	11.3 (± 1.1)	11.3 (± 0.9)	9.0 (± 1.7) *

* $p < 0.05$ for inter-group difference of three different studies

Table 5 shows the prevalence rates when applying cutoff of each guideline to the measurement methods. The prevalence rates of low muscle mass were 24% in overall participants, and rates of low handgrip strength varied from 18% to 38% depending on the criteria of each guideline. The chair stand test ranged from 20% to 41%, and usual gait speed was 2% to 10%. SPPB ranged from 12% to 21%. In all prevalence rates, women tended to be higher than men. Especially the handgrip strength of AWGS1 criteria, usual gait speed and SPPB of AWGS2 criteria showed significant difference between men and women.

Table 5. Diagnostic assessments for each measurement variables.

Measurement Technique	Overall (N=189)	Men (N=66)	Women (N=123)
BIA			
ASM/height^2 (M<7.0, F<5.7)	45 (24%)	14 (21%)	31 (26%)
Handgrip strength			
EWGSOP1 (M<30, F<20)	72 (38%)	21 (32%)	51 (42%)
EWGSOP2 (M<27, F<16)	34 (18%)	10 (15%)	24 (20%)
AWGS1 * (M<26, F<18)	43 (23%)	8 (12%)	35 (29%)
AWGS2 (M<28, F<18)	47 (25%)	12 (18%)	35 (29%)
Chair stand test			
EWGSOP2 (≥15)	37 (20%)	9 (14%)	28 (23%)
AWGS2 (≥12)	77 (41%)	22 (33%)	55 (45%)
Usual gait speed			
EWGSOP1,2 and AWGS1 (≤0.8)	3 (2%)	1 (2%)	2 (2%)
AWGS2 (<1.0) *	19 (10%)	2 (3%)	17 (14%)
SPPB			
EWGSOP1,2 and AWGS1 (≤8)	23 (12%)	4 (6%)	19 (16%)
AWGS2 (≤9) *	40 (21%)	8 (12%)	32 (26%)

* $p < 0.05$ for gender difference

The prevalence rates of sarcopenia according to each diagnostic guideline are summarized in Table 6. The prevalence of sarcopenia was found to be 10%~14%, and as in the individual variable results, the prevalence of women showed higher tendency than that of men in all criteria. The Cohen's kappa coefficient between each guideline ranged from 0.744 to 0.887, which means high degree of agreement. The kappa index between EWGSOP2 and AWGS2 was 0.817.

The kappa index between EWGSOP1 and EWGSOP2 was 0.744, and the prevalence rate decreased from 14% of EWGSOP1 to 10% of EWGSOP2. In EWGSOP1, the rates were higher in low muscle mass combined with low HGS than low muscle mass combined with low physical performance (13% vs 2%). In EWGSOP2 comparing low muscle mass combined with HGS or CST, the trend was maintained but the difference was reduced. (8% vs 3%).

Between two guidelines of AWGS, kappa index was 0.817, and the prevalence increased from 10% to 13% with update. AWGS1 also showed higher tendency of prevalence rate with low muscle mass combined with HGS (10% of HGS vs 1% of UGS, combined with low muscle mass), AWGS2 showed similar proportion between HGS and Physical performance, combined with low muscle mass (11% vs 8%).

Table 6. Prevalence of sarcopenia using each guideline.

Diagnostic guideline	Overall (N=189)	Men (N=66)	Women (N=123)
EWGSOP1 - Sarcopenia (Low BIA + one of below) *	26 (14%)	4 (6%)	22 (18%)
Handgrip strength *	25 (13%)	4 (6%)	21 (17%)
Physical performance	4 (2%)	0 (0%)	4 (3%)
Usual gait speed	1 (1%)	0 (0%)	1 (1%)
SPPB	4 (2%)	0 (0%)	4 (3%)
EWGSOP2 - Sarcopenia (Low BIA + one of below)	18 (10%)	3 (5%)	15 (12%)
Handgrip strength	15 (8%)	2 (3%)	13 (11%)
Chair stand test	6 (3%)	1 (2%)	5 (4%)
AWGS1- Sarcopenia (Low BIA + one of below) *	18 (10%)	0 (0%)	18 (15%)
Handgrip strength *	18 (10%)	0 (0%)	18 (15%)
Usual gait speed	1 (1%)	0 (0%)	1 (1%)
AWGS2- Sarcopenia (Low BIA + one of below)	25 (13%)	5 (8%)	20 (17%)
Handgrip strength *	21 (11%)	3 (5%)	18 (15%)
Physical performance	15 (8%)	2 (3%)	13 (11%)
Chair stand test	14 (7%)	2 (3%)	12 (10%)
Usual gait speed	3 (2%)	0 (0%)	3 (2%)
SPPB	7 (4%)	0 (0%)	7 (6%)

* $p<0.05$ for gender difference

Figure 5 shows the prevalence of sarcopenia using the case finding algorithm (figure 1), assuming that all participants are under clinical suspicion and meet the criteria of case finding such as SARC-F. The prevalence of sarcopenia was higher in AWGS2 than in EWGSOP2 (13% vs 10%), which was exactly the same as the result of Table 6, where the diagnostic criteria were applied non-sequentially. Prevalence of possible and severe sarcopenia according to the AWGS2 algorithm was also higher than with EWGSOP2 (52% vs 32% for possible/probable sarcopenia, 6% vs 2% for severe sarcopenia).

Table 7 shows the differences in characteristics for each diagnosed population according to AWGS2 and EWGSOP2. There was no statistically significant different parameter between the population diagnosed only by AWGS2 and the population diagnosed in both criteria.

Figure 5. Sarcopenia case finding according to AWGS2 and EWGSOP2.

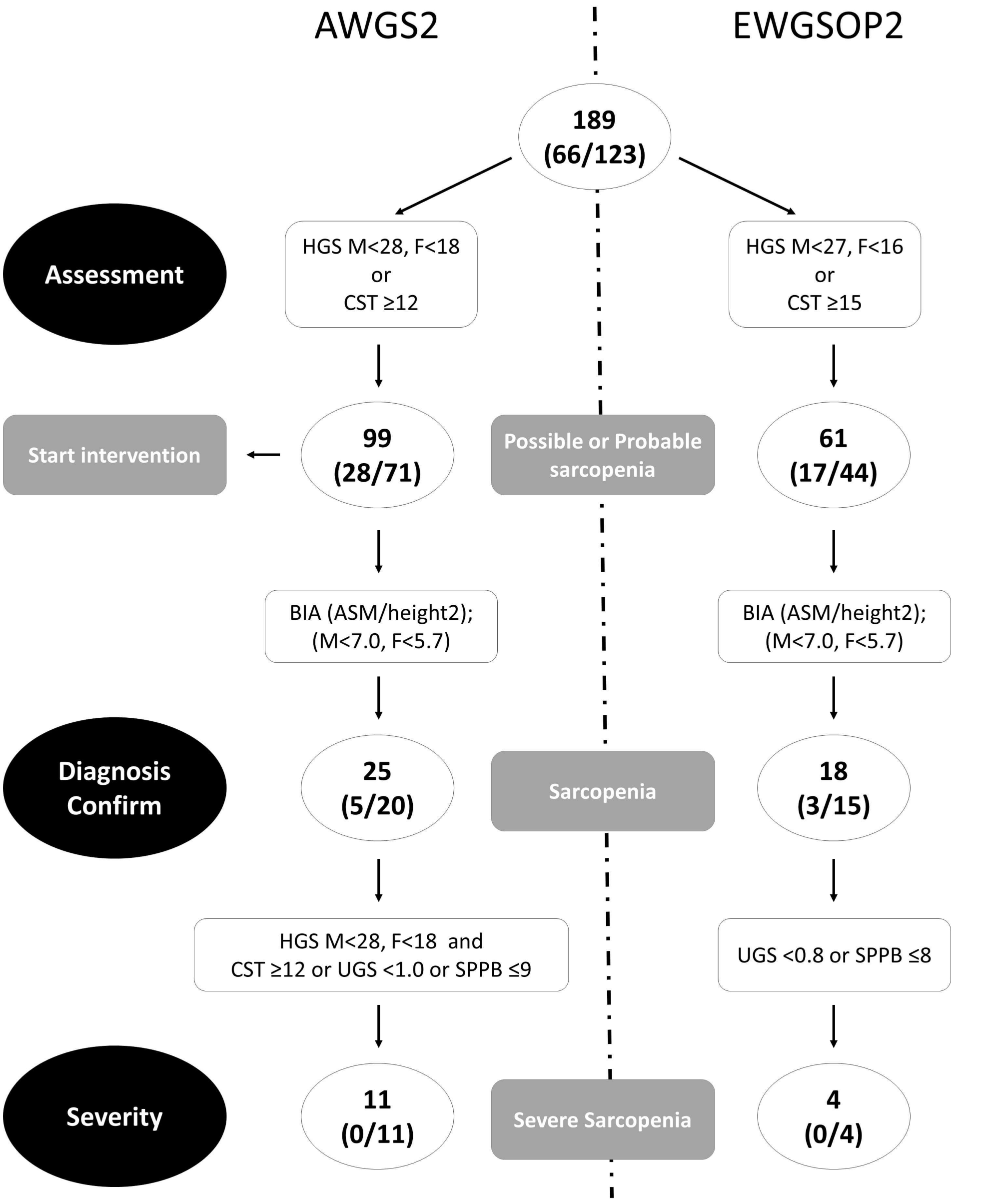


Table 7. Differences in characteristics among individuals with sarcopenia diagnosed by the two diagnostic algorithms (AWGS2 and EWGSOP2).

Variables	No Sarcopenia (N= 164)	Sarcopenia only in AWGS2 (N= 7)	Sarcopenia in both (N= 18)
Age (years)	71.2 (± 4.4)	72.0 (± 5.4)	73.3 (± 8.2)
Sex (M : F)	61 : 103	2 : 5	3 : 15
Height (cm)	157.3 (± 8.9)	156.1 (± 4.2)	151.1 (± 8.0) *
Weight (kg)	61.3 (± 9.4)	56.7 (± 7.2)	52.0 (± 8.2) *
BMI (kg/m2)	24.6 (± 2.6)	23.2 (± 2.2)	22.7 (± 2.7) *
ASM/height2 (kg/m2)	6.9 (± 1.0)	5.7 (± 0.6) *	5.6 (± 0.5) *
Handgrip strength (kg)	25.7 (± 7.2)	21.7 (± 7.6)	16.2 (± 5.6) *
Chair stand test (s)	11.8 (± 4.5)	11.0 (± 2.7)	13.3 (± 4.3)
Usual gait speed (m/s)	1.3 (± 0.2)	1.2 (± 0.2)	1.2 (± 0.2)
SPPB score	10.7 (± 1.6)	11.2 (± 0.8)	9.8 (± 1.7)

* $p<0.05$ for difference with No sarcopenia group
** $p<0.05$ for difference with Sarcopenia only in AWGS2 group

IV. Discussion

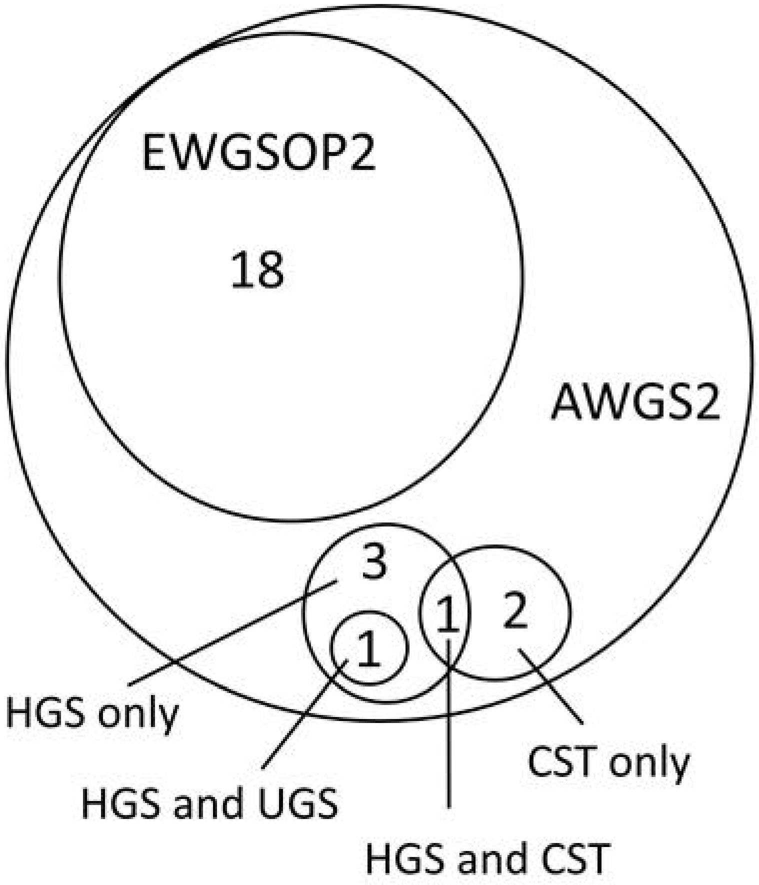
In this study with Korean population, despite major changes in the EWGSOP2 guideline, the agreement with other guidelines was remarkably high. The prevalence of applying each diagnostic guideline was 10-14%, similar to the previous study. [47-50] However, there was a trend of female predominance in all guidelines on our population, which is contrary to previous research results.

Although EWGSOP2 brought a major change, excluding physical performance in sarcopenia diagnosis, the agreement of diagnosis was remarkably high compared to AWGS2. There are several reasons for the high degree of agreement. Some are the reasons for the diagnostic criteria, and some are the reason for the population of this study. The first reason is that CST, the physical performance parameter in AWGS2, is judged as muscle strength parameter in EWGSOP2. CST is a measurement tool included in the SPPB and thus may have some characteristics of physical performance. In EWGSOP2, physical performance was excluded from the diagnostic criteria, but since CST, which has some characteristics of physical performance, was added as a muscle strength parameter, so it can be said that people with decreased "physical performance" were also included in the diagnosis.

Looking at the diagnosed population in detail, those diagnosed only in AWGS2 are those diagnosed only due to UGS and SPPB or those diagnosed with the difference in cutoff values of CST and HGS. In our results, however, it was found that all the diagnosed person only in AWGS2 were diagnosed by the difference in cutoff values of HGS and CST (Figure 6). This may be because of the cutoff of the UGS and SPPB in AWGS2 is too tighter than that of the CST. According to the results in table 5, when applying the cutoff criteria for physical performance of AWGS2, the number of people meeting the cutoff of CST was 77 (41%), much higher than 40 (21%) of SPPB and 19 (10%) of UGS.

However, this may also be due to the characteristics of the population included in this study, especially the mean age. In a study by Kim et al., with a mean age of 76, the number of people diagnosed by UGS was similar to that of CST. [27] Further studies are needed to determine whether worsening of UGS occurs more in the older group than of CST and whether the deterioration of CST precedes the UGS.

Figure 6. Venn diagram of diagnosis distribution of AWGS2 and EWGSOP2



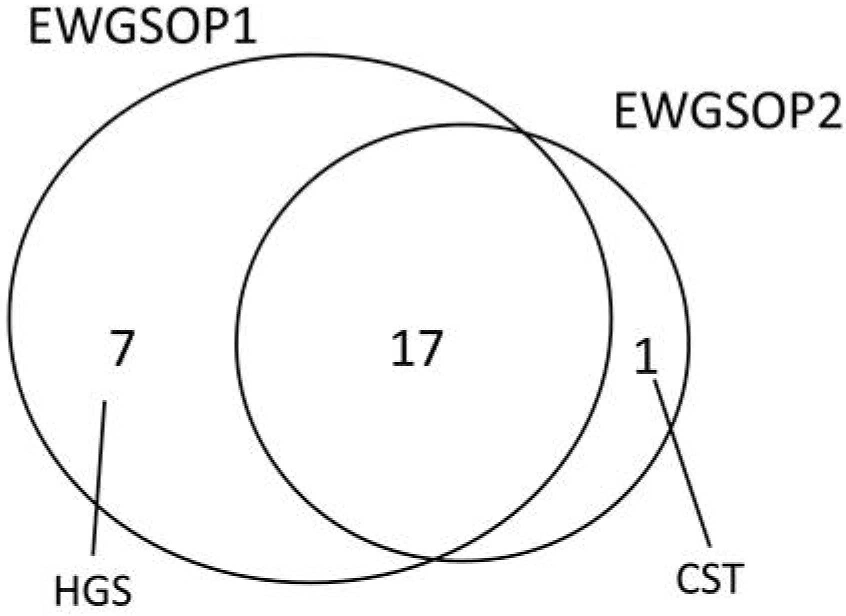
Our results showed a lower prevalence of sarcopenia with EWGSOP2 (10%) compared to EWGSOP1 (14%), and there are several studies comparing the prevalence of EWGSOP1 and 2. Savas et al. reported the high prevalence of EWGSOP2 in Turkish population, with regional skeletal muscle mass (SMM) threshold (0% vs 11.7%). [51] They obtained the fat free mass using BIA and multiplied it by 0.566 to estimate the SMM. And they adjusted it to height and BMI and used each as a standard. However, there was no sarcopenic patient with the height square adjusted regional SMM thresholds for EWGSOP1 and EWGSOP2. Therefore, the prevalence of EWGSOP1 was 0%, and EWGSOP2 was confirmed to be 11.7% by using the BMI adjusted SMM.

De Freitas et al. established the prevalence in elderly patients with type 2 diabetes mellitus, and showed that the prevalence of sarcopenia was more than double when comparing EWGSOP1 (16.9%) and EWGSOP2 (7%). [52] They applied the decreased criteria for muscle mass and muscle strength, respectively, and the newly added muscle strength measurement method, the chair stand test, was not included.

Costanzo et al. Analyzed the prevalence of 65 years or older in the InCHIANTI Study, and confirmed lower prevalence according to EWGSOP2 compared to EWGSOP1 (3.2% vs 6.2%). [53] They investigated the prevalence based only on muscle mass and muscle strength, excluding physical performance, and applied different criteria for each guideline.

The previous two studies confirmed the prevalence of EWGSOP2 similar to ours. As BIA was used for muscle measurement, we also used the regional threshold, but we applied the same standard to both sides to find out the impact of changes in muscle strength and physical performance criteria. As the cutoff value of HGS changed from 30/20 kg to 27/16 kg, 7 patients deviated from the diagnostic criteria. However, according to the newly established chair stand test criteria, 1 person was added confirming that a relatively similar rate was diagnosed. (Figure 7)

Figure 7. Venn diagram of diagnosis distribution of EWGSOP1 and 2.

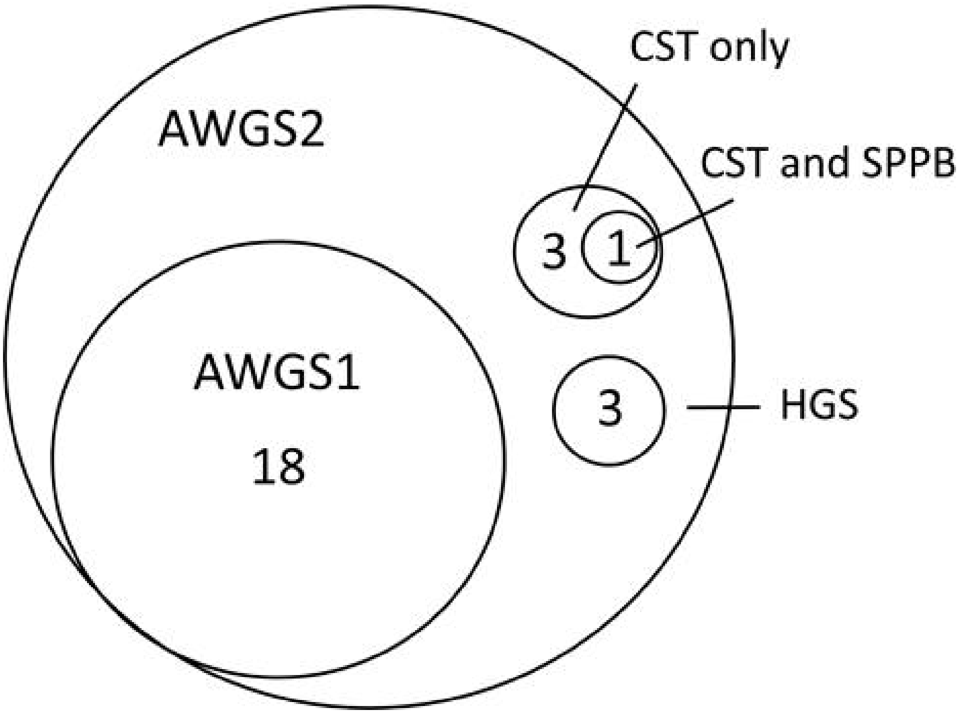


There are also several studies comparing the prevalence of AWGS1 and 2. Tabara et al. [54] established the prevalence in Japan population with the Nagahama study, and found out that the prevalence of revised guideline increased to 5.2%, comparing with 3% prevalence of AWGS1. Among the 47 participants who were newly diagnosed by revised guideline, most of them were diagnosed with low physical performance, especially the CST.

Kim et al. also reported the prevalence in Korean population, and reported that prevalence according to AWGS2 were significantly higher that the AWGS2 (9.2% vs 22.8%). [27] In a subgroup analysis, they found that increasing cutoff values for HGS (from <26 kg to <28.0 kg in men) and UGS (from ≤0.8 to <1.0 m/s) had a significant effect on the increase in prevalence.

As the revised criteria is to be designed to increase the number of diagnoses, our results also confirmed that the prevalence increased (10% of AWGS1 vs 13% of AWGS2). However, it did not increase at a large rate compared to other studies, and 3 and 4 patients were diagnosed by HGS and CST, respectively. (Figure 8) These differences between studies may be due to the difference of characteristics of participants, such as men and women ratio or the average age.

Figure 8. Venn diagram of diagnosis distribution of AWGS1 and 2.



The current study has several limitations. First, the participants of this study are heterogenous because they were recruited from three different studies. In particular, the Sunchang Exercise Intervention Study only recruited the osteoarthritis patients, which may be the main reason that the physical performance parameter was significantly lower compared to other studies. Also, accordingly, the protocol of the measurement method may be different, which in some cases can cause a large difference in prevalence. In particular, in the case of UGS, there are various measurement methods, and a large difference may occur according to each. Further research needs to follow exact recommendations to investigate the prevalence. Second, although this study observed the relationship between cutoff criteria and prevalence, the cutoff value cannot be suggested based on this study result. This is because it is a study that observes a single point in time and does not observe items related to outcomes together. To suggest an appropriate cutoff, outcome-based longitudinal study would be needed.

V. Conclusion

The prevalence using EWGSOP2 guideline is similar with those using other guidelines including AWGS2 is similar, from 10% to 14%, in Korean population when using same regional muscle mass criteria. The degree of agreement between diagnostic guideline is also high, indicating that similar patients are diagnosed despite major changes of EWGSOP2.

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초 록

서론: 근감소증은 노화에 따라 근육량이 감소하며, 이에 따라 근력과 함께 신체 기능이 저하되는 질병이다. 이는 삶의 질을 저하시키고 당뇨병, 비만, 심혈관 질환, 골다공증과 같은 만성 질환의 악화를 유발하며 사망률을 증가시킴으로써 의료 사회 비용을 증가시킨다. 그러나 아직 임상 상황에서 진단과 치료가 잘 적용되지 않고 있는데, 이는 진단 알고리즘이 다양하고 복잡하기 때문이다. European Working Group on Sarcopenia in Older People (EWGSOP)과 Asian Working Group for Sarcopenia (AWGS)은 각각 최근 진단 기준을 업데이트하였으며, 이에 따라 유병률과 진단 분포의 변화가 발생할 것으로 예상된다.

방법: 서울 대학교 노쇠 중재 (SNUFI) 코호트, 보행 프로토콜 연구 및 순창 운동 중재 연구의 데이터를 각각 후향적으로 수집하였다. 221 명의 데이터를 검토하고 이 중 191 명의 지역 사회 거주 노인 데이터를 검토하였다. 데이터는 연속 변수의 경우 평균 (± 표준편차), 범주형 변수의 경우 숫자 (백분율)로 표시하였으며, Cohen's kappa coefficient를 이용하여 각 진단 기준의 일치도를 분석하였다.

결과: 동일한 근육량 기준을 적용하여 유병률을 조사하였을 때, 각 진단 기준 알고리즘을 사용한 근감소증의 유병률에는 유의한 차이가 없었다. EWSGOP 1과 2를 사용한 유병률은 14%, 10% 였으며, AWGS 1과 2를 사용할 때 각각 10 %와 13 % 로 관찰되었다. 각 가이드라인 사이의 진단의 일치도는 0.744에서 0.887로 나타났다.

결론: 한국인 집단에서 동일한 근육량 기준을 사용하여 EWGSOP2의 유병률을 관찰하였을 때 다른 가이드라인과 유사하게 10 %에서 14 %로 관찰되었다. 진단 기준 간의 일치도도 높아, EWGSOP2에서 비교적 진단 기준의 큰 변화가 있었음에도 불구하고 유사한 환자가 진단되었음을 확인하였다.

주요어: 근감소증, 근력, 근육량, 신체 기능, 진단 기준, 유병률

학번: 2019-26365