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Impact of using the updated EWGSOP2 definition in diagnosing sarcopenia: A clinical perspective

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ABSTRACT

Background and Purpose: The revised European Working Group on Sarcopenia in Older People (EWGSOP2, version 2019) definition of sarcopenia differs with respect to the EWGSOP (version 2010) definition in applied criteria and their cut-off values. We aimed to investigate the impact of the new definition on sarcopenia prevalence in various populations of older adults.

Methods: Eight cohorts, including community-dwelling older adults, geriatric outpatients and patients admitted to acute and subacute inpatient wards were assessed on sarcopenia prevalence.

Results: A total of 2256 participants (56.4 % female) were included with a median age of the cohorts of 71.7–83.3 years. In males, sarcopenia prevalence was 31.9 % according to EWGSOP compared to 12.0 % according to EWGSOP2. In females, sarcopenia prevalence was 4.9 % and 6.1 % according to EWGSOP and EWGSOP2 respectively. Lower cut-off points for handgrip strength (27 kg versus 30 kg (males) and 16 kg versus 20 kg (females) for EWGSOP and EWGSOP2 respectively) resulted in the lower sarcopenia prevalence in males.

Conclusions: According to the EWGSOP2 definition, the prevalence of sarcopenia in males is significantly lower compared to the EWGSOP definition, whereas the prevalence among women is slightly higher. The lower cut-off points for handgrip strength result in fewer adults being diagnosed with sarcopenia.

1. Introduction

Sarcopenia is associated with detrimental clinical outcome such as falls and fractures (Yeung et al., 2019), cognitive impairment (Cabett-Cipolli, Sanches-Yassuda, & Aprahamian, 2019), hospitalization (Zhang, Zhang, Wang, Tao, & Dou, 2018), and all-cause mortality (Liu et al., 2017) among older adults. Consequently, sarcopenia has been reported to impose a significant economic burden on healthcare services (Janssen, Shepard, Katzmarzyk, & Roubenoff, 2004). A valid, evidence-based consensus definition for sarcopenia is critical to translate the concept of sarcopenia from research to the clinical setting (Reijnierse, de van der Schueren et al., 2017; Van Ancum et al., 2019). Accordingly, several operational definitions of sarcopenia have emerged during the last decade (Chen et al., 2014; Cruz-Jentoft et al., 2010; Fielding et al., 2011; Morley et al., 2011; Muscaritoli et al., 2010; Studenski et al., 2014; Zanker et al., 2018), with little concordance in

Abbreviations: ASM, appendicular skeletal muscle; DSM-BIA, direct segmental multifrequency bioelectrical impedance analysis; DXA, dual-energy x-ray absorptiometry; EWGSOP, European Working Group on Sarcopenia in Older Peopl; IQR, interquartile range; HGS, handgrip strength; SD, standard deviation; SMM, skeletal muscle mass

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intra-individual sarcopenia prevalence (Bijlsma, Meskers, Ling et al., 2013; Reijnierse, Buljan et al., 2019, 2015). Most definitions align in defining sarcopenia as low muscle mass and muscle strength combined with low physical performance, including the definition provided by the European Working Group on Sarcopenia in Older People (EWGSOP) in 2010 (Cruz-Jentoft et al., 2010). Specifically, the EWGSOP defined sarcopenia as a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength, which diagnosis requires presence of low muscle mass plus either low muscle strength or low physical performance (Cruz-Jentoft et al., 2010). The use of two standard deviations below the sex-specific means of a young reference group was recommended as cut-off points for sarcopenia diagnosis (Cruz-Jentoft et al., 2010).

In 2019 the EWGSOP released the updated EWGSOP2 sarcopenia definition (Cruz-Jentoft et al., 2019a). The main differences are: 1) diagnosis requires documentation of low muscle strength and low muscle mass, while physical performance is used to categorize the severity of sarcopenia; and 2) new cut-off points were recommended (Cruz-Jentoft et al., 2019a). Brief reports have already pointed out discrepancies between the prevalence of sarcopenia when applying the EWGSOP and EWGSOP2 definitions (Locquet, Beaudart, Petermans, Reginster, & Bruyere, 2019; Phu et al., 2019; Reiss et al., 2019). The released version of the EWGSOP2 definition was updated due to an error regarding the recommended cut-off points for women (Cruz-Jentoft et al., 2019b). The impact on sarcopenia prevalence in cohorts of different ages and diseases has yet to be established.

The aim of the present study was to compare the prevalence of sarcopenia using the EWGSOP and the EWGSOP2 definition and to assess the impact of different criteria cut-off points of the EWGSOP2 on the prevalence of sarcopenia in multiple cohorts of older adults.

2. Material and methods

Participants of the following eight cohorts were included if they were 65 years or older, and if both muscle mass and handgrip strength (HGS) measurements were available: Copenhagen Sarcopenia study (Suetta, 2017), including community-dwelling older adults living in Copenhagen, Denmark (data collection 2013–2017, ethics University of Copenhagen H-3-2013-124), patients with acute medical illness, surgery within the last 3 months, ongoing medication known to affect body composition and history of prolonged immobilization were excluded; Grey Power cohort (Rojer et al., 2017; Van Ancum et al., 2019), including community-dwelling older adults visiting educational events at different locations in The Netherlands (data collection 2014–2018, ethics VU University Medical Center in Amsterdam (VUmc) 2015.454, 2017.597), no exclusion criteria were applied; Myoage cohort (McPhee et al., 2013), including community-dwelling older adults from The Netherlands, Finland, France, UK, and Estonia (data collection 2010–2013, ethics Leiden University Medical Center P10.060), exclusion criteria were aimed to ensure a selection of healthy individuals free from major diseases: dependent living status, inability to walk a distance of 250 m, morbidity (neurologic disorders, metabolic diseases, rheumatic diseases, recent malignancy, heart failure, severe chronic obstructive pulmonary disease and coagulation disorders), use of specific medication (immunosuppressive drugs and insulin), immobilization for one week during the previous 3 months and orthopedic surgery during the past 2 years or still causing pain or functional limitation; Falls outpatients cohort (Christensen, Piper, Dreier, Suetta, & Andersen, 2018), including adults referred to the geriatric outpatients clinic at the Rigshospitalet in Copenhagen, Denmark (data collection 2015, ethics University of Copenhagen H-3-2013-124), patients with acute medical illness, surgery within the last 3 months, ongoing medication known to affect body composition and history of prolonged immobilization were excluded; COGA cohort (Mol et al., 2018), including adults referred to the geriatric outpatients clinic at the VUmc in Amsterdam, The Netherlands (data collection 2014–2015, ethics VUmc P05-160, P00-211), no exclusion criteria were applied; Bronovo cohort (Reijnierse, de Jong et al., 2017), including adults referred to the geriatric outpatient clinics at the Bronovo Hospital in The Hague, the Netherlands (data collection 2011–2012, ethics LUMC), no exclusion criteria were applied; RESt0Ring health of acutely unwell adulTs (RESORT) cohort (Clark, Reijnierse, Lim, & Maier, 2020), including geriatric rehabilitation patients at the Royal Melbourne Hospital, Melbourne, Australia (data collection 2017–2018, ethics Melbourne Health HREC/17/MH/103), patients receiving palliative care, transferred to acute care prior to consenting to the study and incapable of providing informed consent (e.g. patients with delirium or severe dementia) without a nominated proxy were excluded; and EMPOWER cohort (Van Ancum et al., 2017), including hospitalized older patients admitted to the VU University Medical Center, Amsterdam, The Netherlands (data collection 2015–2016, ethics VUmc 2015.164), patients were excluded when they were nursed in air-pressure isolation rooms, suffering from terminal illness, expected to be discharged within 24 h, or could not be assessed within 48 h after admission.

2.1. Muscle measures

Muscle mass was assessed using dual-energy X-ray absorptiometry (DXA) in the Copenhagen Sarcopenia Study and Falls outpatient cohort (iDXA, GE Lunar, Encore version 16.0), and in the Myoage cohort (UK: Lunar Prodigy Advance, version EnCore 10.50.086; France: Lunar Prodigy, version EnCore 12.30; Netherlands: Hologic QDR 4500, version 12.4; Estonia: Lunar Prodigy Advanced, version EnCore 10.51.006; Finland: Lunar Prodigy, version EnCore 9.30). Muscle mass was assessed using direct segmental multifrequency bioelectrical impedance analysis (DSM-BIA) in RESORT and EMPOWER (In-Body S10, Biospace Co., Ltd, Seoul, Korea), Grey Power (In-Body S10 and 230, Biospace Co., Ltd, Seoul, Korea), COGA and Bronovo (In-Body 720, Biospace Co., Ltd, Seoul, Korea) cohorts. DSM-BIA is a validated method for estimating muscle mass compared with DXA (Ling et al., 2011).

HGS in kg was assessed using a Jamar hand-grip dynamometer in all cohorts, and the maximum score out of 3–6 attempts was used (Reijnierse, de Jong et al., 2017).

Habitual gait speed expressed as m/s was assessed using the 4-meter walk test in the Grey Power, COGA, Bronovo and RESORT cohorts, using the 10-meter walk test in the Copenhagen Sarcopenia Study and Falls outpatients cohort and using the 6-minute walk test in the Myoage cohort (all with static starts).

Gait speed assessment was not performed in the EMPOWER cohort including acutely hospitalized patients.

2.2. Sarcopenia

Applying the EWGSOP definition, muscle mass was expressed as appendicular skeletal muscle mass (ASM)/height^2 using DXA, with cut-off points for males < 7.26 kg/m^2 and females < 5.5 kg/m^2 and skeletal muscle mass (SMM)/height^2 using BIA, with cut-off points for males ≤ 10.75 kg/m^2 and females ≤ 6.75 kg/m^2. HGS cut-off points were defined as < 30 kg for males and < 20 kg for females. The cut-off point for gait speed was ≤ 0.8 m/s. Sarcopenia was present if gait speed or HGS were below the cut-off points, combined with muscle mass below the cut-off points.

For the EWGSOP2 definition, muscle mass for both DXA and BIA was expressed as ASM with cut-off points for males < 20 kg and females < 15 kg, and ASM/height^2 with cut-off points for males < 7.0 kg/m^2 and females < 5.5 kg/m^2. The cut-off points for HGS were < 27 kg for males and < 16 kg for females. Gait speed is used to distinguish between sarcopenia and severe sarcopenia. Sarcopenia was present if HGS was below the cut-off points, combined with muscle mass below the cut-off points.

Table 1
Cohorts' characteristics.

Variables		Copenhagen Sarcopenia N = 519	Grey Power N = 375	Myoage N = 315	Falls outpatients N = 95	COGA N = 72	Bronovo N = 140	RESORT N = 419	EMPOWER N = 321
Age, years, median [IQR]		74.0 [69.0–78.0]	71.7 [68.0–76.3]	73.7 [71.6–77.1]	80.0 [75.0–85.0]	80.3 [76.1–84.1]	81.6 [76.9–85.8]	83.3 [77.2–87.7]	79.0 [74.0–84.0]
Females, n (%)		291 (56)	234 (62)	159 (51)	62 (65)	37 (51)	81 (58)	246 (59)	163 (51)
Setting		Community-dwelling	Community-dwelling	Community-dwelling	Outpatients	Outpatients	Outpatients	Subacute inpatients	Acute inpatients
HGS, kg	♂	40.4 (8.9)	39.9 (10.1)	40.1 (7.7)	33.5 (7.4)	24.8 (8.5)	33.1 (6.0)	21.8 (7.3)	26.7 (10.0)
	♀	23.8 (5.7)	25.3 (6.4)	26.0 (4.9)	19.6 (5.2)	14.6 (7.5)	21.3 (5.1)	13.9 (5.5)	14.9 (5.6)
Gait speed, m/s	♂	1.56 (0.36)	1.4 (0.2)	1.5 (0.3)	1.29 (0.57)	0.9 (0.3)	0.8 (0.3)	0.5 (0.2)	N/A
	♀	1.39 (0.32)	1.3 (0.2)	1.5 (0.2)	1.09 (0.41)	0.9 (0.3)	0.7 (0.2)	0.4 (0.2)	N/A
BIA									
SMM/height^2, kg/m^2	♂	N/A	10.5 (1.0)	N/A	N/A	9.9 (1.2)	10.0 (1.1)	9.5 (1.3)	9.7 (1.5)
	♀	N/A	9.0 (0.9)	N/A	N/A	8.9 (1.1)	8.6 (1.2)	8.5 (1.4)	8.6 (1.2)
ASM, kg	♂	N/A	26.0 (3.7)	N/A	N/A	22.9 (4.4)	24.2 (3.9)	22.2 (4.8)	23.4 (5.1)
	♀	N/A	18.7 (2.7)	N/A	N/A	17.0 (2.7)	17.5 (3.9)	16.4 (4.4)	16.9 (3.7)
ASM/height^2, kg/m^2	♂	N/A	8.2 (0.8)	N/A	N/A	7.6 (1.1)	7.8 (0.8)	7.8 (1.4)	7.6 (1.3)
	♀	N/A	6.9 (0.8)	N/A	N/A	6.6 (0.9)	6.7 (1.2)	6.7 (1.5)	6.5 (1.2)
DXA									
ASM, kg	♂	24.5 (3.7)	N/A	24.2 (3.1)	22.5 (3.8)	N/A	N/A	N/A	N/A
	♀	17.0 (2.5)	N/A	16.6 (2.6)	17.0 (3.4)	N/A	N/A	N/A	N/A
ASM/height^2, kg/m^2	♂	7.8 (1.0)	N/A	8.0 (0.7)	7.3 (1.2)	N/A	N/A	N/A	N/A
	♀	6.4 (0.9)	N/A	6.4 (0.7)	6.5 (1.2)	N/A	N/A	N/A	N/A

Variables are given as mean (SD) unless otherwise stated. ASM: Appendicular Skeletal Muscle Mass. BIA: Bioelectrical impedance analysis. DXA: Dual-energy X-ray absorptiometry. HGS: Handgrip strength. SMM: Skeletal Muscle Mass.

2.3. Statistical analyses

Descriptive statistics were performed, with continuous variables with a normal distribution presented as mean with standard deviation (SD), variables with a skewed distribution (non-Gaussian) were presented as median with interquartile range (IQR), and categorical variables were presented as numbers (n) with percentage (%). The impact of the EWGSOP2 cut-off points for ASM/height^2 on the prevalence of sarcopenia compared to the cited cut-off points published by Gould et al. (Gould, Brennan, Kotowicz, Nicholson, & Pasco, 2014) (< 6.94 kg/m^2 for males and < 5.30 kg/m^2 for females) was assessed.

3. Results

The eight cohorts included a total of 2256 participants, of whom 56.4 % were female, with a median age of the cohorts of 71.7–83.3 years (Table 1).

Table 2 outlines the percentages of participants with low HGS, muscle mass, gait speed and the prevalence of sarcopenia according to the EWGSOP and EWGSOP2 definitions. The sarcopenia prevalence in males was on average 31.9 % according to the EWGSOP definition, compared to 11.5 % (based on ASM) and 12.0 % (based on ASM/height^2) using the EWGSOP2 definition. In females, on average 4.9 % of participants had sarcopenia based on the EWGSOP definition, compared to 11.3 % (based on ASM) and 6.1 % (based on ASM/height^2) using the EWGSOP2 definition.

The prevalence of low HGS was lower in both males and females according to the EWGSOP2 definition compared to the EWGSOP definition. Out of all participants, 296 (13.1 %) had a HGS between the cut-off points used in the EWGSOP and EWGSOP2 definitions (between 27 kg–30 kg for males, and 16 kg–20 kg for females) of whom 36.1 % (n = 107, 4.7 % of all included participants) had low ASM/height^2 based on the EWGSOP2 definition. This resulted in a 35 % reduction in the number of participants being deemed sarcopenic (13.4 % versus 8.7 %).

The prevalence of low muscle mass according to the EWGSOP2 definition was lower in males and higher in females when compared to the EWGSOP definition (Table 2). The cut-off points used for AMS/height^2 according to the EWGSOP2 definition (< 7.0 kg/m^2 for males and < 5.5 kg/m^2 for females) were compared to the cut-off points proposed by Gould et al. (Gould et al., 2014) (< 6.94 kg/m^2 for males and < 5.30 kg/m^2 for females) resulting in a slightly higher prevalence of low ASM/height^2 (20.1 % versus 18.9 %) and sarcopenia (12.0 % versus 11.4 %) in males and significantly higher prevalence of low ASM/height^2 (12.6 % versus 8.0 %) and sarcopenia (6.1 % versus 4.6 %) in females (Supplementary Table 1).

The percentage of participants not diagnosed with sarcopenia while having a low ASM/height^2 according to EWGSOP was 18.4 % for males and 2.2 % for females (Fig. 1) and 8.1 % for males and 6.5 % for females according to EWGSOP2 (Fig. 2). The percentage of participants not diagnosed with sarcopenia while having a low HGS according to EWGSOP was 3.2 % for males and 18.9 % for females (Fig. 1) and 15.1 % for males and 19.1 % for females according to EWGSOP2 (Fig. 2).

4. Discussion

The prevalence of sarcopenia in males was lower according to the EWGSOP2 definition compared to the EWGSOP definition. The prevalence of sarcopenia in females was slightly higher using the EWGSOP2 compared to the EWGSOP definition and depended on the use of ASM or ASM/height^2 as diagnostic criteria. The proposed lower cut-off points for HGS in the EWGSOP2 definition resulted in a significant lower number of participants being deemed abnormal for the criterion muscle strength of the sarcopenia definition. The adaptation of the cut-off points for muscle mass led to a slightly higher prevalence of abnormal muscle mass.

The term 'sarcopenia' was first coined in 1989 by Irwin Rosenberg to describe the decline in muscle mass caused by aging. Since then it has been given increasing attention due to its potential serious consequences on mobility and independence among older individuals (Baumgartner et al., 1998; Castillo et al., 2003; Evans & Campbell, 1993; Evans, 1995; Gillette-Guyonnet et al., 2003; Iannuzzi-Sucich, Prestwood, & Kenny, 2002; Janssen, Baumgartner, Ross, Rosenberg, & Roubenoff, 2004; Janssen, Heymsfield, & Ross, 2002; Lau, Lynn, Woo, Kwok, & Melton, 2005; Melton, Khosla, & Lawrence Riggs, 2000; Tanko, Movsesyan, Mouritzen, Christiansen, & Svendsen, 2002). In 1998, Baumgartner et al. (1998) created the foundations for the diagnosis of sarcopenia, which was defined as ASM normalized to height^2 two standard deviations below the sex-specific mean of a young reference group. This operational definition was accepted by several experts in the field (Morley, Baumgartner, Roubenoff, Mayer, & Nair,

Table 2
Prevalence of low handgrip strength, low muscle mass, low gait speed and sarcopenia dependent on EWGSOP and EWGSOP2 definitions.

Cohorts	EWGSOP					EWGSOP2				
	Low HGS	Low muscle mass		Low gait speed	Sarcopenia	Low HGS	Low muscle mass		Sarcopenia	
	♂ < 30 kg ♀ < 20 kg	SMM/height^2 ♂ ≤ 10.75 kg/m^2 ♀ ≤ 6.75 kg/m^2	ASM/height^2 ♂ < 7.26 kg/m^2 ♀ < 5.5 kg/m^2	≤ 0.8 m/s	low gait speed/HGS & muscle mass	♂ < 27 kg ♀ < 16 kg	ASM ♂ < 20 kg ♀ < 15 kg	ASM/height^2 ♂ < 7.0 kg/m^2 ♀ < 5.5 kg/m^2	low HGS & ASM	low HGS & ASM/height^2
Copenhagen	♂21 (9.2)	N/A	65 (28.4)	1 (0.4)	14 (6.1)	11 (4.8)	23 (10.0)	44 (19.2)	4 (1.7)	7 (3.1)
Sarcopenia	♀77 (26.5)	N/A	35 (12.0)	6 (2.1)	22 (7.6)	19 (6.5)	74 (25.4)	35 (12.0)	12 (4.1)	7 (2.4)
Grey Power	♂16 (11.3)	85 (60.3)	N/A	0 (0)	16 (11.3)	13 (9.2)	5 (3.5)	5 (3.5)	3 (2.1)	3 (2.1)
	♀38 (16.2)	1 (0.4)	N/A	3 (1.9)	0 (0)	16 (6.8)	18 (7.7)	2 (0.9)	4 (1.7)	0 (0)
Myoage	♂12 (7.7)	N/A	23 (14.7)	0 (0)	6 (3.8)	3 (1.9)	10 (6.4)	10 (6.4)	1 (0.6)	1 (0.6)
	♀12 (7.5)	N/A	12 (7.5)	0 (0)	2 (1.3)	2 (1.3)	43 (27.0)	12 (7.5)	0 (0)	0 (0)
Falls outpatients	♂8 (24.2)	N/A	15 (45.5)	5 (15.2)	8 (24.2)	6 (18.2)	10 (30.3)	11 (33.3)	5 (15.2)	5 (15.2)
	♀33 (53.2)	N/A	14 (22.6)	12 (19.4)	11 (17.7)	13 (21.0)	23 (37.1)	14 (22.6)	7 (11.3)	4 (6.5)
COGA	♂26 (74.3)	27 (77.1)	N/A	13 (37.1)	22 (62.9)	20 (57.1)	8 (22.9)	9 (25.7)	7 (20.0)	6 (17.1)
	♀27 (73.0)	0 (0)	N/A	14 (37.8)	0 (0)	21 (56.8)	8 (21.6)	3 (8.1)	5 (13.5)	2 (5.4)
Bronovo	♂15 (25.4)	43 (72.9)	N/A	29 (49.2)	29 (49.2)	7 (11.9)	8 (13.6)	14 (23.7)	5 (8.5)	6 (10.2)
	♀27 (33.3)	4 (4.9)	N/A	52 (65.0)	4 (4.9)	11 (13.6)	24 (29.6)	13 (16.0)	4 (4.9)	2 (2.5)
RESORT	♂143 (82.7)	144 (83.2)	N/A	112 (64.7)	136 (78.6)	123 (71.1)	64 (37.0)	49 (28.3)	57 (32.9)	42 (24.3)
	♀208 (84.6)	18 (7.3)	N/A	161 (65.4)	17 (6.9)	152 (61.8)	109 (44.3)	47 (19.1)	76 (30.9)	36 (14.6)
EMPOWER	♂96 (60.8)	120 (75.9)	N/A	N/A	83 (52.5)	83 (52.5)	34 (21.5)	56 (35.4)	31 (19.6)	48 (30.4)
	♀124 (76.1)	8 (4.9)	N/A	N/A	7 (4.3)	87 (53.4)	53 (32.5)	35 (21.5)	36 (22.1)	27 (16.6)
Total	**♂337 (34.3)**	**419 (74.0)**	**103 (24.7)**	**160 (16.3)**	**314 (31.9)**	**266 (27.1)**	**162 (16.5)**	**198 (20.1)**	**113 (11.5)**	**118 (12.0)**
	♀546 (42.9)	**31 (4.1)**	**61 (11.9)**	**248 (19.5)**	**63 (4.9)**	**321 (25.2)**	**352 (27.7)**	**161 (12.6)**	**144 (11.3)**	**78 (6.1)**

Variables are given as number (percentage) unless otherwise stated. ASM: Appendicular skeletal muscle mass. HGS: Handgrip strength. SMM: Skeletal muscle mass.

2001; Morley, 2008), and subsequently used in several studies (Gillette-Guyonnet et al., 2003; Iannuzzi-Sucich et al., 2002; Lau et al., 2005; Tanko et al., 2002).

Although low muscle mass is associated with an increased risk of disability (Baumgartner et al., 1998; Janssen et al., 2002; Melton et al., 2000), muscle strength is known to be more strongly associated with impaired physical performance (Lauretani et al., 2003; Visser, Deeg, Lips, Harris, & Bouter, 2000), disability (Visser et al., 2005), and to be an independent predictor of self-reported incident walking limitations (Visser et al., 2005) and mortality (Ling et al., 2010; Newman et al., 2006) in older adults.

These findings led to the notion that measures of muscle mass should be complemented with measures of muscle strength for a better management of sarcopenia (Lauretani et al., 2003; Morley, 2008; Visser, 2009). Thus, sarcopenia was defined as low muscle mass and strength that occurs with aging by some (Lauretani et al., 2003; Morley et al., 2001; Roubenoff & Hughes, 2000), while others proposed the differentiation between sarcopenia and 'dynapenia' (age-related loss of muscle strength) (Clark & Manini, 2008; Janssen, 2010).

The fact that muscle mass and muscle strength are different constructs (Suetta et al., 2019) has been underlined by evidence showing that HGS has poor diagnostic accuracy to identify older adults with low lean mass, since only half of individuals with low lean mass were identified based on HGS testing in geriatric outpatients (Looijaard et al., 2018). Additionally, a study conducted on 11,270 older adults found that only 1 in 5 men and 1 in 3 women with low ASM experienced low muscle strength (Cawthon et al., 2014). This is in accordance with our study showing that a proportion of older males and females with low ASM/height^2 or HGS were not deemed sarcopenic according to both definitions. Also there were differences in the prevalence of relative and absolute low muscle mass, which might be of importance as relative and absolute muscle mass measures relate differently to both muscle strength and physical performance measures (Bijlsma et al., 2014). The inclusion of muscle mass in the definition of sarcopenia is a topic of debate, mainly due to a predominantly non-significant association of muscle mass with the incidence of adverse health outcomes in community dwelling older adults (Bhasin et al., 2020). However, a recent meta-analysis underlined the predictive capacity of muscle mass with future activities of daily living dependence in older adults (Wang, Yao, Zirek, Reijnierse, & Maier, 2020). The association of muscle mass with relevant clinical outcomes might also be dependent on the populations being studied; significant associations of muscle mass were found with ADL (Meskers et al., 2019), geriatric syndromes (Van Ancum et al., 2017) and mortality (Reijnierse, Verlaan et al., 2019) in hospitalized older patients. Importantly, low muscle mass per se (without the presence of low muscle strength) can contribute to other negative outcomes associated with aging such as lower resting metabolic rate (McMurray, Soares, Caspersen, & McCurdy, 2014; Muller, Bosy-Westphal, Kutzner, & Heller, 2002) and consequent increase in body fat (Hunter, Weinsier, Gower, & Wetzstein, 2001), or disrupted glucose metabolism (Akasaki et al., 2014; LeBrasseur, Walsh, & Arany, 2011) and lower bone mineral density (Bijlsma, Meskers, Molendijk et al., 2013). Hence, it is important to include an assessment of muscle mass to be able to identify older individuals with low muscle mass despite sufficient muscle strength.

The focus of the EWGSOP2 definition has been on muscle mass and muscle strength, whereas physical performance is used to determine the severity of sarcopenia. Physical performance is one of the most potent predictors of future health outcome in older individuals (Liu et al., 2016; Pavasini et al., 2016). Next to that, physical performance is easy to measure in daily clinical practice, whereas muscle strength and muscle mass measurements rely on specific measurement equipment not readily available in most (primary) care settings (Reijnierse, de van der Schueren et al., 2017). The use of physical performance defining severity of sarcopenia instead of using it as first diagnostic step, as suggested in the EWGSOP, is therewith debatable (Bulow, Ulijaszek, & Holm, 2019, b, Langer et al., 2019). In addition, this aspect introduces further variation in the prevalence of sarcopenia between the EWGSOP and EWGSOP2 definitions. Alternatively, muscle mass, muscle strength and physical performance could be recognized as distinct domains of muscle function and treatment could be specifically focused on the type of muscle dysfunction. Recently, we therefore proposed to use the term

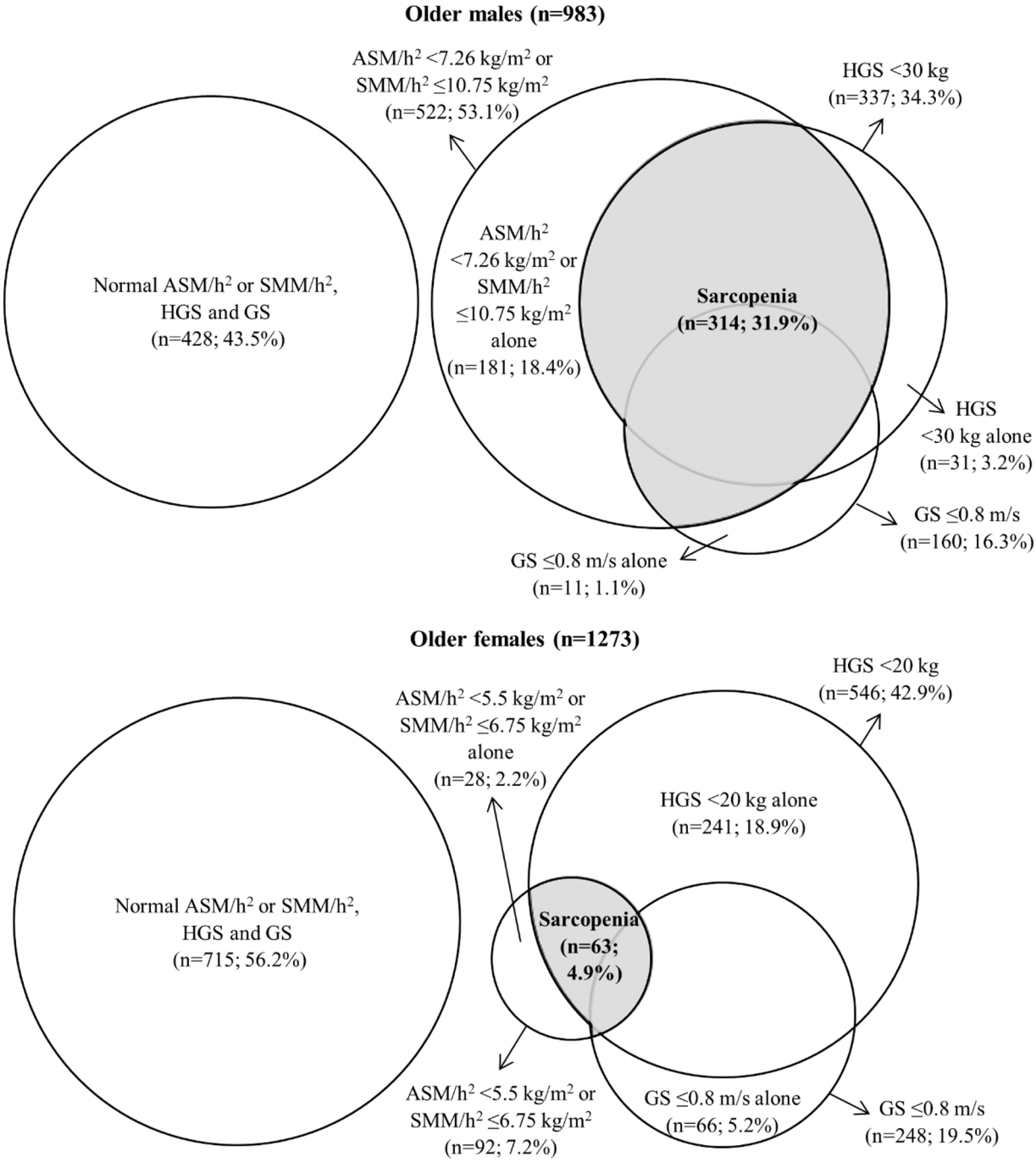

Fig. 1. Venn diagram showing percentages of males and females with normal lean/muscle mass, muscle strength and gait speed, low lean/muscle mass, low muscle strength, low gait speed, and sarcopenia according to the EWGSOP. ASM, appendicular skeletal muscle. GS, gait speed. HGS, handgrip strength. h^2, height squared. SMM, skeletal muscle mass.

'Muscle Failure' as umbrella term for sarcopenia (low muscle mass), dynapenia (low muscle strength) and low physical function (Suetta & Maier, 2019).

The consequence of the lower cut-off points for HGS in the EWGSOP2 definition is clearly seen in the differences in prevalence of low HGS compared to EWGSOP2. The reason why in the EWGSOP2 definition cut-offs of −2.5 standard deviations of the mean reference value were chosen, in contrast to −2 standard deviation for other muscle measures, are not stated in the definition paper (Cruz-Jentoft et al., 2019a). Furthermore, an evidence based approach for the deviation of cut-offs for muscle mass (EWGSOP2 muscle mass cut-off < 5.5 kg/m2 versus < 5.3 kg/m2 as stated in the paper by Gould et al. (Gould et al. (2014) and for the chair stand test (EWGSOP2 chair stand test cut-off > 15 s versus > 17.1 s as stated in the paper by Cesari et al. (2009)) is missing. The argument that rounding numbers, for the ease of use, will only lead to a minor reduction in precision, is misleading as accuracy cannot be given in the lack of a gold standard.

This study is not without limitations. A variety of cohorts including diverse populations were included, therefore different investigators and techniques to test muscle measures were used. Muscle mass was

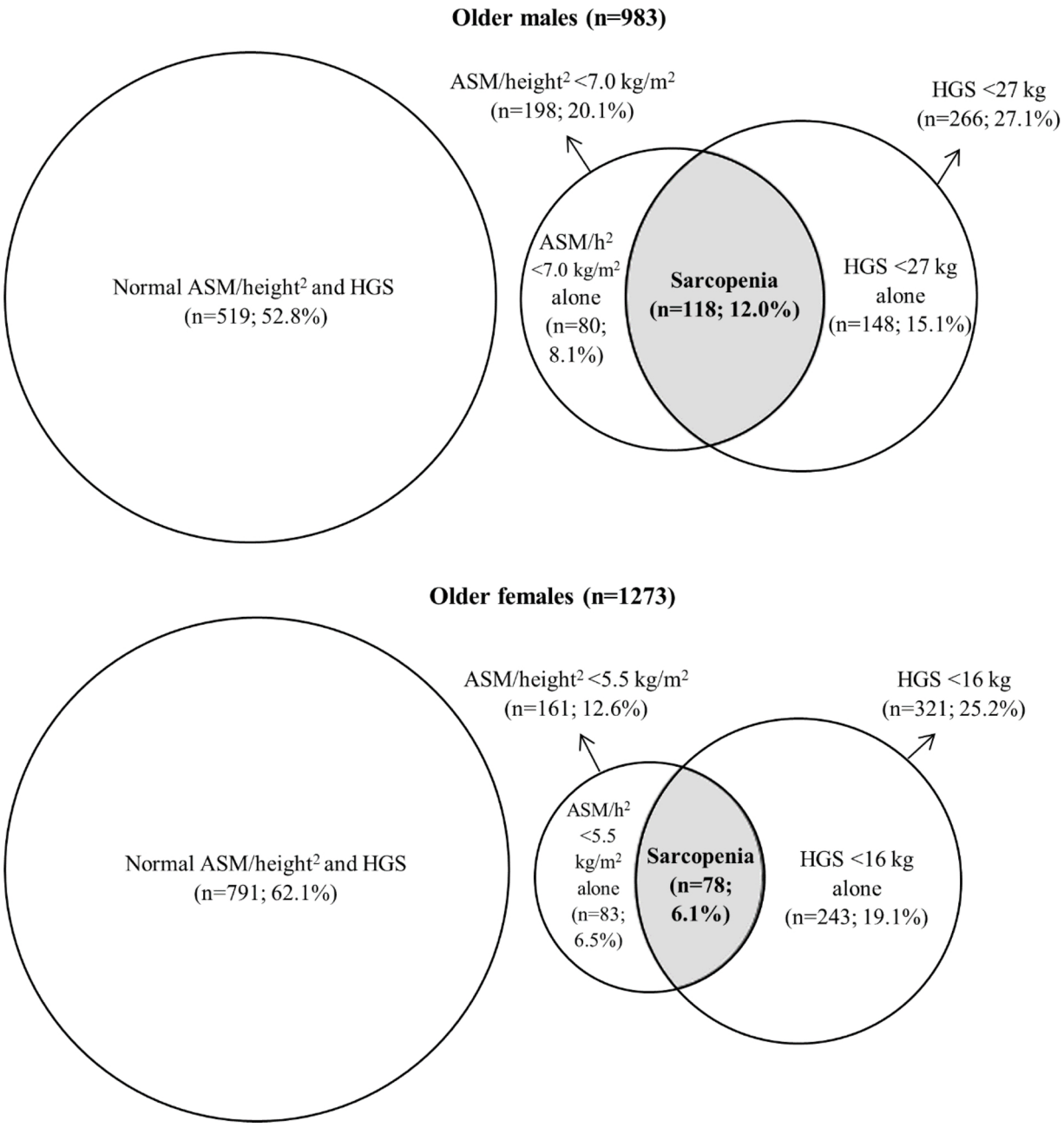

Fig. 2. Venn diagram showing percentages of males and females with normal lean/muscle mass and muscle strength, low lean/muscle mass, low muscle strength, and sarcopenia according to the EWGSOP2. ASM, appendicular skeletal muscle. HGS, handgrip strength. h^2, height squared.

predominantly assessed by DSM-BIA and DXA, whereas other techniques such as computer tomography or magnetic resonance imaging might have higher validity to estimate muscle mass. Walking was assessed using different protocols, which can affects walking speed (Pasma et al., 2014).

5. Conclusions

The introduction of the EWGSOP2 definition for sarcopenia substantially affects the prevalence of sarcopenia being lower for males and slightly higher for females compared to the EWGSOP definition. Despite the intention to simplify diagnosing sarcopenia, the new recommendation may have introduced new potential difficulties. Notably, by using very low (−2.5 SD) cut-off values (e.g. for HGS) many older individuals with low physical performance status and/or low muscle mass may be overlooked with the new recommendation.

Ethical approval

Ethical approval was obtained from the local ethical committees for each of the cohorts included in this manuscript.

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CRediT authorship contribution statement

Jeanine M. Van Ancum: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Julian Alcazar:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing -

original draft, Writing - review & editing. **Carel G.M. Meskers:** Conceptualization, Resources, Writing - review & editing. **Barbara Rubæk Nielsen:** Conceptualization, Resources, Writing - review & editing. **Charlotte Suetta:** Conceptualization, Investigation, Methodology, Resources, Supervision, Writing - original draft, Writing - review & editing. **Andrea B. Maier:** Conceptualization, Investigation, Methodology, Resources, Supervision, Writing - original draft, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.archger.2020.104125.

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