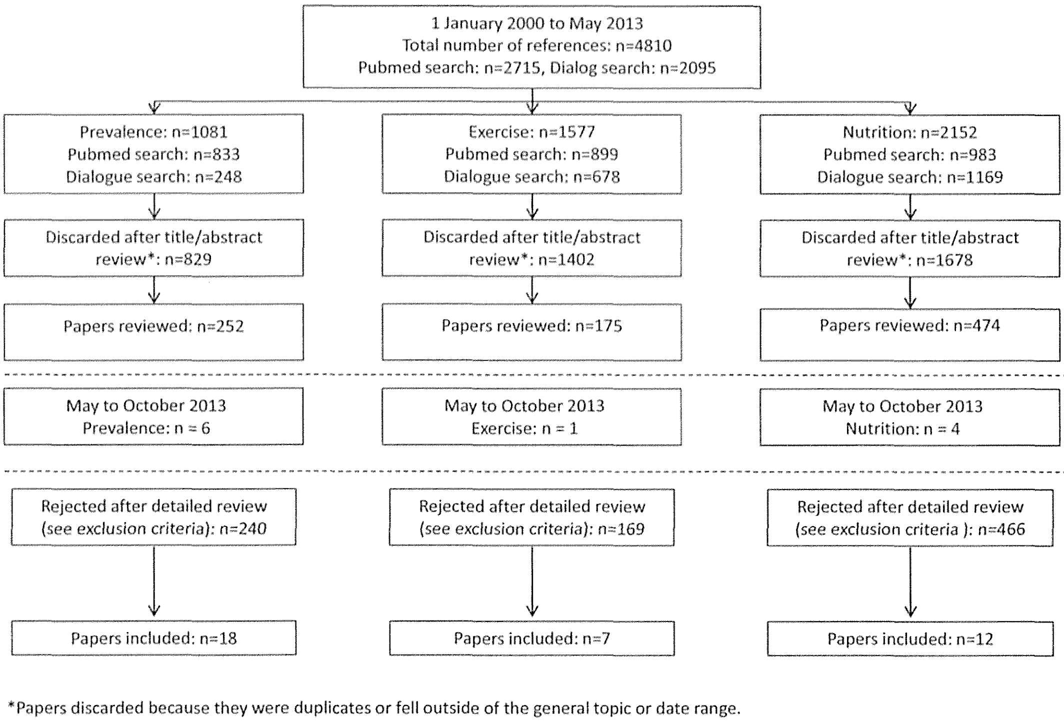

Figure 1. Selection of papers.

was divided into three subgroups (prevalence, exercise and nutrition). Final papers selected for inclusion in each of the three categories were agreed upon by each subgroup consensus.

Data synthesis

Data tables were compiled independently for each topic. For the prevalence of sarcopenia category, data were recorded on demographics (country, gender and age), assessment method used for each domain (muscle mass, muscle strength and physical performance) and sarcopenia prevalence. For the interventional categories, data were collected on population, numbers studied (by gender), age, intervention, control group, duration of intervention, outcomes measured and the main results. The methodological quality of each randomised, controlled trial was assessed using the 11-point Physiotherapy Evidence Database (PEDro) scale. Each item on the scale that the trial satisfied (except for item 1, which assesses external validity and is not included in the total score) contributed one point to the total PEDro score, with 0 representing the lowest score and 10 the highest [4]. This scale was specifically developed to rate the quality of randomised, controlled trials evaluating physical therapist interventions.

The following questions were investigated in patients aged 50 years and older without comorbid conditions. What is the prevalence of sarcopenia in different populations? Is physical exercise (as physical activity, resistance training or endurance training) effective compared with control in improving measures of muscle loss, muscle mass, muscle strength and physical performance? Compared with control, does nutrition supplementation improve measures of muscle mass, muscle strength, and physical performance? Based on the answers to these questions, draft recommendations were proposed by the co-chairs, and the working group then reviewed these recommendations to reach a consensus.

Results

Overall, 4810 publications were identified (Figure 1). Of these, 3909 were excluded, leaving 901 publications for potential inclusion (prevalence: 252; exercise: 175; nutrition: 474). In addition, 11 papers were identified as suitable for inclusion as a result of a short search of PubMed and Dialog databases to identify articles published in the period May–October 2013.

Eighteen prevalence, 7 exercise and 12 nutrition papers were finally chosen by the working group members for inclusion within this review (Figure 1).

Estimates of prevalence

Of the 18 prevalence studies meeting the inclusion criteria, 15 (83%) were in community-dwelling patients [5, **6–9**, 10, 11, **12, 13**, 14, 15, **16**, 17, **18**, 19], with two studies in patients in long-term care institutions [**20, 21**], and one publication in the acute hospital-care setting [22] (Table 1). The reporting of age varied across studies, but for those where the mean age was given, this ranged from 59.2 to 85.8 years [5, **6–9**, 10, 11, **12, 13**, 14, **16**, 17, **18**, 19, **21**].

Table 1. Prevalence of sarcopenia

Reference	Date data collected	Country	M/F, *n*	Assessment method			Age, years Mean (SD) [Range]	Sarcopenia prevalence, %		
				Muscle mass	Muscle strength	Physical performance		Total	Male	Female
Community-dwelling populations										
Abellan van Kan *et al.* [5]	Jan 1992–Jan 1994	France	0/3025	DEXA	HS	GS	80.51 (3.9) [≥75]	5.2	–	5.2
Landi *et al.* [6]	Oct 2003	Italy	66/131	MAMC	HS	GS	82.2 (1.4) [80–85]	21.8	25.7	19.8
Landi *et al.* [7]	Oct 2003	Italy	118/236	MAMC	HS	GS	85.8 (4.9)	29.1	27.1	30.1
Lee *et al.* [8]	–	Taiwan	223/163	DXA	HS, KE, PEF	SPPB, GS, TUG, or SCPT	73.7 (5.6)	7.8[a] 16.6[b]	10.8[a] 14.9[b]	3.7[a] 19.0[b]
Legrand *et al.* [9]	Nov 2008–Sep 2009	Belgium	103/185	BIA	HS	mSPPB, GS	84.8 (3.6) [>80]	12.5	14.6	12.4
Malmstrom *et al.* [10]	Sep 2000–Jul 2001	USA (African Americans)	124/195	DEXA	–	GS	59.2 (4.4)	4.1	–	–
McIntosh *et al.* [11]	–	Canada	42/43	BIA	HS	GS	75.2 (5.7)	6.0	S: 5 SS: 0	S: 7 SS: 0
Murphy *et al.* [12]	–	USA	1426/1502	DEXA	HS	GS	F: 73.5 (2.88) M: 73.8 (2.85) Total: [70–79]	S: 5	–	–
Patel *et al.* [13]	–	UK[c]	Cohort A: 103/0 Cohort B: 765/1022	DEXA, SFT	HS	GS, TUG, chair-rise time	(A): 72.5 (2.5) (B): M, 67.0 (2.6); F, 67.1 (2.6)	(A): 6.8 (B): 7.8	4.6	7.9
Patil *et al.* [14]	–	Finland	0/409	DEXA	HS	GS, SPPB, TUG	74.2 (3.0) [70–80]	0.9	–	0.9
Sanada *et al.* [15]	–	Japan	0/533	DEXA	HS, LEP	Sit and reach, VO_{2max}	<39: 11.4% <49: 21.2% <59: 25.9% <69: 29.8% <85: 11.6% [30–84]	24.2	–	24.2
Tanimoto *et al.* [16]	May–Jun 2007, 2008, 2009	Japan	364/794	BIA	HS	GS	M: 74.4 (6.4) F: 73.9 (6.3) [≥65]	–	11.3	10.7
Verschueren *et al.* [17]	–	Belgium, UK	679/0	DEXA	HS, KE	GS	59.6 (10.7) [40–79]	S: 3.7 SS: 0	–	–
Volpato *et al.* [18]	2004–2006	Italy	250/288	BIA	HS	GS	77.1 (5.5) [65–97]	10.2	2.6	6.7
Yamada *et al.* [19]	–	Japan	568/1314	BIA	HS	GS	74.9 (5.5) [65–89]	–	21.8	22.1
Institutional dwelling										

Continued

Table 1. Continued

Reference	Date data collected	Country	M/F, n	Assessment method			Age, years Mean (SD) [Range]	Sarcopenia prevalence, %		
				Muscle mass	Muscle strength	Physical performance		Total	Male	Female
Bastiaanse et al. [20]	–	Netherlands	450/434	CC	HS	GS	50–59: 46.5% 60–69: 35.2% 70–79: 16.2% ≥80: 2.1% [≥50]	All: 14.3 50–64: 12.7 ≥65: 17.4	–	–
Landi et al. [21]	Aug–Sep 2010	Italy	31/91	BIA	HS	GS	84.1 (4.8) [≥70]	32.8	67.7	20.8*
Acute hospital care										
Gariballa and Alessa [22]	–	UK	227/205	MAMC	HS	–	[≥65]	10.2	–	–

ALM, appendicular lean mass; BIA, bioelectrical impedance analysis; CC, calf circumference; DEXA, dual-energy X-ray absorptiometry; F, female; GS, gait speed; HS, hand-grip strength using a dynamometer; KE, knee extensor; LEP, leg extension power; M, male; MAMC, mid-arm muscle circumference; PEF, peak expiratory flow; S, sarcopenia; SCPT, stair-climb power test; SD, standard deviation; SFT, skin-fold thickness; (m)SPPB, (modified) standard physical performance battery; SS, severe sarcopenia; TUG, timed-up-and-go; VO_{2max}, maximal oxygen uptake.

[a]By relative appendicular skeletal muscle index.

[b]By percentage skeletal muscle index.

[c]Consists of two cohorts (Cohort A: detailed data were collected. Cohort B: same data were collected, but no DEXA).

*$P < 0.001$ versus females.

The prevalence of EWGSOP-defined sarcopenia was 1–29% (up to 30% in women) for older adults living in the community [5, **6–9**, 10, 11, **12, 13**, 14, 15, **16**, 17, **18**, 19], 14–33% (up to 68% in men) for those living in long-term care institutions [**20, 21**] and 10% for those in acute hospital care [22]. Age was not consistently reported across the studies, with some giving mean ages only, others reporting ranges, and others breaking age down into categories; thus, a comprehensive analysis of prevalence based on age could not be made. However, where reported, the majority of studies suggested the prevalence of sarcopenia increased with age [18, 19, **22**]. However, one study appeared to show a decrease in sarcopenia prevalence with increasing age [**20**]. In one study, sarcopenia appeared to be related to gender, with males more commonly affected than females [**21**], while another study showed a numerically higher prevalence of sarcopenia and severe sarcopenia in women than in men [**13**]. In a further study, the prevalence of sarcopenia was higher in women than in men in those aged <75 years; but, in those aged >85 years, the prevalence of sarcopenia was higher in men than in women ($P < 0.05$) [19]. However, in most studies that reported gender, there was no significant association with sarcopenia prevalence [**6–9**, 11, **16**, 19, **20**].

Exercise interventions

There were seven moderate quality (PEDro score: 4–6) intervention studies that investigated the effect of exercise on muscle parameters in different populations aged 60–95 years (Table 2) [23–29]. The impact of exercise on sarcopenia was assessed using muscle mass and muscle strength or power measures in all studies [23–29]; assessment of physical performance (chair rise [24], 12-min walk [**25**], stair climbing [29] or timed up and go [**27, 28**]) was carried out in five of seven studies (Table 2).

Resistance training interventions

Resistance training was explored in four mixed-gender studies (Table 2) [**23–25**, **29**]. When used from 3–18 months, resistance training interventions alone improved muscle mass in two of four studies [**23, 29**] and muscle strength in three of four studies [**23, 25, 29**] compared with control (low-intensity home exercise or standard rehabilitation). Physical performance (chair rise, stair climb or 12-min walk) improved with resistance training alone versus control in all three studies assessing this parameter [**24, 25, 29**].

Combined exercise/physical activity interventions

Three additional studies explored compound exercise interventions (with different blends of aerobic, resistance, flexibility and/or balance training), which were performed for 3–18 months [**26–28**]. A high-intensity multipurpose exercise programme over 18 months improved muscle mass, muscle strength and physical performance versus control (wellbeing) in a study in 246 women [**27**]. In two mixed-gender studies

Table 2. Summary of the effect of exercise on sarcopenia in randomised, controlled studies meeting the inclusion criteria

Reference	Population	Number studied (M/F)	Age, years Mean (SD) [Range]	Intervention		PEDro score	Outcomes measured	Main results
				Description	Duration (months)			
Binder *et al.* [23]	Frail, community-dwelling	91	83 (4)	Progressive RET; CON (low-intensity home exercise)	9	5	MM (DEXA), MS (KE)	Total body FFM increased in the progressive RET group, but not in the CON group ($P = 0.005$) MS increased to a greater extent in the progressive RET than in the CON group ($P = 0.05$)
Bonnefoy *et al.* [24]	Frail, care institution	57 (7/50)	83	RET + SUPP; CON + SUPP; RET + PLA; PLA + CON	9	5	MM (FFM by labelled water), MP, PP (chair rise)	RET did not improve MM or MP, but improved PP versus CON ($P = 0.01$)
Bunout *et al.* [25]	Community-dwelling	98 (36/62)	≥70	RET + SUPP; SUPP; RET; CON	18	4	MM (DEXA), MS (quadriceps strength), PP (12-min walk)	FFM did not change in any group RET improved MS versus CON ($P < 0.01$) PP remained constant in RET group, but declined in the CON group ($P < 0.01$).
Suetta *et al.* [29]	Frail, post-operative elective hip replacement	36 (18/18)	[60–86]	RET; ES; CON (standard rehabilitation)	3	5	MM (US), MS (quadriceps), PP (stair climbing)	RET improved MM, MS and PP versus CON (all $P < 0.05$) In the ES or CON groups, there was no increase in any measurement outcomes
Goodpaster *et al.* [26]	Sedentary, community-dwelling	42 (11/31)	[70–89]	PA (aerobic, strength, flexibility, balance training); CON (health education)	12	5	MM (CT scan), MS (KE)	MM decreased in both groups (but losses were not different between groups) MS loss was decreased in CON, but completely prevented in PA (between group change not significant)
Kemmler *et al.* [27]	Community-dwelling	246 (0/246)	69.1 [65–80]	High-intensity multipurpose exercise programme; CON (wellbeing)	18	6	MM (DEXA), MS (isometric leg extension), PP (timed up and go)	Multipurpose exercise was associated with significant improvements in MM ($P = 0.008$), MS ($P = 0.001$), PP ($P < 0.001$) versus CON
Rydwik *et al.* [28]	Frail, community-dwelling	96 (38/58)	>75	PA (aerobic, muscle strength, balance exercises); nutrition intervention; PA + nutrition intervention; CON	3	5	MM [FFM = BW-fat mass (skin folds)], MS (leg press, dips), PP (timed up and go)	PA improved MS ($P < 0.01$ for dips), but did not improve MM or PP versus CON

BW, body weight; CON, control; CT, computerised tomography; DEXA, dual-energy X-ray absorptiometry; ES, electrical stimulation; F, female; FFM, free-fat mass; FM, fat mass; KE, knee extension; M, male; min, minute; MM, muscle mass; MP, muscle power; MS, muscle strength; RET, resistance exercise training; PA, physical activity; PLA, placebo; PP, physical performance; SD, standard deviation; SUPP, nutritional supplement; US, ultrasound.

[26, 28], muscle mass did not improve; muscle strength (assessed as dips) improved with physical activity versus control at 3-months follow-up in one of the two studies [28]; and physical performance did not improve in the one study in which it was assessed [28].

Overall, most exercise trials showed improved muscle strength and physical performance (using different measures), but only three of seven studies found increased muscle mass. These trials were largely performed in community-dwelling older people, sometimes identified as frail by different measures.

Nutrition interventions

Most studies (11/12) evaluating nutrition intervention in adults aged 50 years and over (Table 3) were in community-dwelling populations whose age ranged from 62 to 90 years ($n = 14$–98) [25, 30–39]. One study assessed individuals living in care institutions (mean age, 83 years; $n = 57$) [24]. Nutrition interventions that were identified included protein supplementation (usually with other nutrients providing extra calories) [24, 25, 30, 37, 38], amino acid (mainly leucine) supplementation [33, 35], β-hydroxy β-methylbutyric acid (HMB; a bioactive metabolite of leucine) supplementation with arginine [34] or alone [32, 34, 36, 39] or fatty acid supplementation [31] administered over 8–36 weeks to evaluate changes in muscle mass and/or strength and function.

Protein supplements

Protein supplementation (with other nutrients providing ∼400 extra kilocalories/day in three of five studies) either alone or in addition to resistance exercise training was evaluated in five moderate- to high-quality (PEDro score: 4–10) studies [24, 25, 30, 37, 38]. In the only high-quality study with no associated exercise in a frail, community-dwelling population, protein supplementation improved physical performance, but not muscle mass or muscle strength versus control [38]. Only in one of the four moderate- to high-quality studies using different types and amounts of protein supplementation in addition to an exercise programme for 24 weeks to 18 months [24, 25, 30, 37], was muscle mass increased over the control group [40]. Muscle strength did not change in any of the studies; only a transient increase in muscle power was found in one study [24]. Physical performance did not improve in any of these four studies.

Overall, these five moderate- to high-quality studies fail to show a consistent effect of protein supplementation on muscle mass and function [24, 25, 30, 37, 38].

Essential amino acid supplementation

The effect of essential amino acid (EAA) supplementation either alone [33] or in combination with resistance exercise training [35] on muscle parameters was investigated in two high-quality (PEDro score: 7 and 8) studies of 3 month's duration each, in community-dwelling individuals. Daily leucine amount provided was 2.8 and 2.5 g. EAA improved muscle mass in one of two studies [33], did not improve muscle strength, and improved physical performance in the study that used this outcome [35]. When combined with exercise, EAA improved leg muscle mass and muscle strength but not physical performance versus health education at 3 months [35].

Overall, very limited evidence on EAA supplementation seems to show some effects on muscle mass and function.

HMB supplementation

The effect of HMB alone [32, 36] or HMB in combination with ARG and LYS [34] or resistance exercise training [39] on muscle parameters has been investigated in four high-quality (PEDro score: 8–10) studies of 8–24-week duration in community-dwelling older adults [34, 36, 39] or in healthy older adults on extended bed rest [32]. HMB prevented muscle mass loss in one of four studies and did not improve muscle mass in the other three [32]; improved muscle strength in one [34] (and possibly two) [36] of four studies and improved physical performance in one of four studies [34].

Overall, HMB showed some effects on muscle mass and function in these high-quality studies, but sample sizes were small.

Fatty acids

The only study examining the effect of fatty acid supplementation (α-linolenic acid) on muscle parameters (PEDro score: 10), in 51 older adults undergoing resistance training for 12 weeks, showed no effect of the supplementation on muscle mass or muscle strength versus placebo [31].

Discussion

Sarcopenia is an independent risk factor for adverse outcomes, including difficulties in instrumental and basic ADL [6, 10, 16, 20, 21], osteoporosis [17], falls [21], hospital length of stay and re-admission [22] and death [6]. This underscores the importance of understanding the true prevalence of sarcopenia and effective preventative strategies.

Prevalence

The prevalence of sarcopenia in the literature varies widely, and is likely to be affected by the population studied (including the population under investigation and the reference population) and the different methods used to assess muscle mass, muscle strength and physical performance [3]; although results may also be due to real differences in prevalence of sarcopenia. As studies that defined sarcopenia as muscle mass plus muscle strength/physical performance were few, comparisons of prevalence across studies were difficult due to the different methods and cut-off points

Table 3. Summary of the effect of nutrition on sarcopenia in randomised, controlled studies meeting the inclusion criteria

Reference	Population	Number studied (M/F)	Age, years, mean (SD) [range]	PEDro Score	Intervention (duration)	Outcomes measured	Main results
Bonnefoy *et al.* [24]	Frail, care institution	57 (7/50)	83	5	RET + SUPP (400 kcal, 30 g of protein/day); CON + SUPP; RET + PLA; PLA + CON (9 months)	MM (FFM by labelled water), MP, PP (chair rise, 6-min walk, stair climb)	SUPP significantly increased MP at 3 months versus CON ($P = 0.03$), but not at 9 months SUPP did not improve MM or PP versus CON
Bunout *et al.* [25]	Community-dwelling	98 (36/62)	[≥70]	4	RET + SUPP (400 kcal, 13 g of protein/day); SUPP; RET; CON (18 months)	MM (DEXA), MS (biceps and quadriceps strength), PP (12-min walk)	SUPP alone had no effect on MM, MS or PP SUPP did not show an additive effect over RET outcome
Chale *et al.* [30]	Sedentary, community-dwelling	80 (33/47)	[70–85]	10	WPS (378 kcal, 40 g of protein/day) + RET; CON (378 kcal, no protein) + RET (6 months)	MM (DEXA, CT scan), MS (KE), PPPP (stair climb, chair rise, 400 m walk, SPPB)	WPS + RET did not improve MM, MS or PP significantly versus CON + RET
Tieland *et al.* [37]	Frail, community-dwelling	62 (21/41)	PLA: 79 (6) Protein: 78 (9) [≥65]	10	Protein (30 g/day) + RET; PLA + RET (24 weeks)	MM (DEXA), MS (leg press, LE, HS), PP (SPPB)	Protein + RET significantly improved MM ($P = 0.006$), but not MS or PP versus PLA + RET
Tieland *et al.* [38]	Frail, community-dwelling	65 (29/36)	PLA: 81 (±1 SEM) Protein 78 (±1 SEM) ≥65	8	Protein (30 g/day); PLA; (24 weeks)	MM (DEXA), MS (leg press, LE, HS), PP (SPPB)	PP improved significantly with protein supplementation ($P = 0.02$), but not MM or MS versus PLA
Dillon *et al.* [33]	Healthy individuals	14 (0/14)	All: 68 (±2) PLA: 69 (±3) Supplement: 67 (±1)	7	EAA (HIS, ILE, LEU, LYS, MET, PHE, THR, VAL); PLA; (3 months)	MM (DEXA), MS (bicep curl, triceps extension, LE, leg curl)	EAA increased MM versus baseline, ($P < 0.05$) There were no changes in MS
Kim *et al.* [35]	Community-dwelling	155 (0/155)	79 (2.9) [≥75]	8	EAA (LEU, LYS, VAL, ILE, THR, PHE) + RET; EAA; RET; HE (3 months)	MM (BIA), MS (KE), PP (max. walking speed)	EAA alone improved PP, but not MM and MS versus HE EAA + RET improved leg (not appendicular or total) MM ($P < 0.007$) and, MS ($P = 0.02$) versus HE PP was not more improved by the addition of EAA than by RET alone
Flakoll *et al.* [34]	Community-dwelling	57 (0/57)	76.7 [62–90]	8	ARG + HMB + LYS; PLA (12 weeks)	MM (BIA), MS (isometric leg strength, HS), PP (get up and go)	MS ($P \leq 0.05$) and PP ($P = 0.002$) significantly improved with ARG + HMB + LYS versus PLA ARG + HMB + LYS did not significantly improve MM versus PLA
Deutz *et al.* [32]	Healthy individuals on bed rest	19 (4/15)	PLA: 67.1 (±1.7) HMB: 67.4 (±1.4) [60–76]	10	HMB; PLA Bed rest (10 days) + rehabilitation (8 weeks)	MM (DEXA), MS (KE, leg press), PP (SPPB, get up and go, 5-item PPB)	Bed rest caused a significant decrease in MM ($P = 0.02$) in the PLA group, but MM was preserved in the HMB group Changes in MS and PP were not significant for HMB versus PLA

Continued

Table 3. Continued

Reference	Population	Number studied (M/F)	Age, years, mean (SD) [range]	PEDro Score	Intervention (duration)	Outcomes measured	Main results
Stout *et al.* [36]	Community-dwelling	98 (49/49)	73 (±1 SEM) [≥65]	9	Phase I: HMB; PLA (24 weeks) Phase II: PLA + RET; HMB + RET (24 weeks)	MM (DEXA), MS (isokinetic leg strength, HS), PP (get up and go)	HMB alone significantly improved some, but not all measures of MS versus PLA. No significant changes were found in MM and PP with HMB versus PLA Adding HMB to RET did not improve any parameters over RET alone
Vukovich *et al.* [39]	Community-dwelling	31 (15/16)	70 (±1)	10	HMB + RET; PLA + RET (8 weeks)	MM (DEXA, CT scan), MS (misc. upper and lower body strength press, flexion and extension measurements)	MM improved with HMB + RET versus PLA + RET, but not significantly ($P = 0.08$) MS did not improve with HMB + RET versus PLA + RET
Cornish and Chilibeck [31]	Community-dwelling	51 (28/23)	65.4 (±0.8)	10	ALA + RET; PLA + RET (12 weeks)	MM (DEXA, US), MS (leg press, chest press)	ALA + RET had minimal effect on MM or MS versus PLA + RET

ALA, α-linolenic acid; ARG, arginine; BIA, bioelectrical impedance analysis; CON, controls; CT, computerised tomography; DEXA, dual X-ray absorptiometry; EAA, essential amino acid; F, female; FFM, fat-free mass; HE, health education; HIS, histidine; HMB, β-hydroxy β-methylbutyrate; ILE, isoleucine; HS, hand-grip strength; KE, knee extension; LE, leg extension; LEU, leucine; LYS, lysine; M, male; min, minute; MET, methionine; MM, muscle mass; MP, muscle power; MS, muscle strength; NS, not significant; PHE, phenylalanine; PLA, placebo; PP, physical performance; RET, resistance exercise training; SD, standard deviation; SPPB, standard physical performance battery; SUPP, nutritional supplement; THR, threonine; VAL, valine; WPS, whey protein supplement.

used. The prevalence of sarcopenia in the community using a definition consistent with EWGSOP was 1–33% across different populations (male and female data combined), with higher prevalence, as expected, in settings where older, more complex or acutely ill individuals are cared for. Ethnicity may also play a role, especially if the reference and study populations do not match.

After careful consideration of the methodological limitations and scope of these studies, the ISI group proposes certain recommendations for the design of future studies (expert advice):

- Studies with sufficient sample size to identify prevalence and risk factors for sarcopenia, including subpopulation analyses, are needed.
- Studies should focus on standardised, well-defined, reproducible populations, namely community-dwelling individuals, individuals living in nursing homes/care homes, and acutely ill or physically frail inpatients. These populations should be clearly described so that studies can be compared for external validity.
- Standardised models and cut-off points should be used for each domain of the definition of sarcopenia to allow comparison between studies.
- Longitudinal studies on the incidence of sarcopenia are needed, again using standard methods.

Exercise intervention

Exercise interventions appear to have a role in increasing muscle strength and improving physical performance, although they do not seem to consistently increase muscle mass, in frail, sedentary, community-dwelling older individuals. Investigations in other populations are still anecdotal. No trials were found that recruited individuals based on their sarcopenic status. The results suggested that combining various types of exercise into a programme may also improve muscle strength and physical performance. Most exercise studies involved limited participants and were mainly conducted within a single country.

Recommendations for the design of exercise studies (expert advice):

- Improved standardisation of exercise interventions is needed, to allow for replication and contrast.
- Studies should have common outcome measures, along with similar time points for assessment (e.g. 4 weeks, 8 weeks, 3 months, 6 months, 1 year), so that valid comparisons across studies can be made. The short physical performance battery, gait speed, 400-m walking distance and grip strength are proposed as useful measures of physical performance that are able to determine clinically significant changes. Grip strength, chair rise and knee extension may be used to measure muscle strength.
- Exercise interventions should focus on well-defined populations, with well-defined sarcopenia.

Nutrition intervention

Although nutrition intervention is considered one of the mainstays of intervention in sarcopenia, much of the evidence is based on short-term protein synthesis studies, and large clinical trials are still lacking. Our review has failed to show a consistent effect of protein supplementation, although the number of studies found using our strict selection criteria was very low. EAAs (with ~2.5 g of leucine) and HMB seem to have some effects on muscle mass and muscle function that need to be confirmed in larger trials. Vitamin D studies were evaluated as part of the review process; while some epidemiological studies link vitamin D levels with muscle parameters, there were no intervention studies meeting the criteria for inclusion in this review. Similarly, there is a large literature on the effects of omega 3-fatty acids on muscle parameters, especially in cachexia, but only one negative study was found in this review [**31**]. Interventions that evaluated the combined effects of exercise and nutrition sometimes suggested a potential additive effect, although this needs further research. However, solid evidence on which to base recommendations for patients with sarcopenia is not available.

Recommendations for the design of nutrition studies (expert advice)

- Further studies are needed to determine the effect of different nutrition interventions on muscle mass and function using robust, multi-centre and standardised approaches with single or complex nutrition interventions and clinically relevant outcomes (muscle strength, physical performance).
- Studies using four arms (exercise, nutrition, both or none) should also be conducted. The choice of exercise and nutrition interventions should be based on the singular effect of each intervention.
- Outcome measures for such studies should not differ from those used for individual components, and reporting should allow for individual group comparisons to also evaluate the role of each component.
- Timing of nutrition intervention before or after exercise should be explored in clinical trials comparing different times of administration, as basic studies suggest there may be time-associated differences in the effect of nutrition intervention over exercise.
- Baseline nutritional status and physical frailty of the population should be considered when doing nutrition intervention studies.

Practice recommendations

Sarcopenia is a common clinical problem in people over 50 years of age, and one that leads to severe adverse outcomes. Research on management interventions is advancing quickly, but questions still remain. Based on our current understanding, the expert group agreed some general recommendations for clinical practice (expert opinion):

(1) Sarcopenia, defined as low muscle mass and low muscle function and/or reduced physical performance, occurs in at least 1 in 20 community-dwelling individuals, and prevalence may be as high as 1 in 3 in frail older people living in nursing homes (Table 1).
   - Owing to the consequences of sarcopenia on quality of life, disability and mortality, it is recommended that physicians should consider screening for sarcopenia, both in community and geriatric settings.
   - The new definitions of sarcopenia, based on muscle mass and function, should be preferred to definitions based on muscle mass alone.

(2) Exercise interventions, especially those based on resistance training, may have a role in improving muscle strength and physical performance (moderate quality evidence), but not muscle mass. Moreover, exercise has been shown to improve other common conditions in adults and older patients, as well as being safe.
   - Supervised resistance exercise or composite exercise programmes may be recommended for frail or sedentary community-dwelling individuals.
   - Time of intervention of at least 3 months and probably longer may be needed to obtain significant improvement in relevant clinical parameters (muscle strength and physical performance). Increased physical activity in daily life may also be recommended in these individuals.

(3) Some nutrition interventions such as EAAs (with ~2.5 g of leucine) and HMB may improve muscle parameters. Although our findings did not appear to support this approach, increasing protein intake to 1.2 g/kg body weight/day, either by improving diet or adding protein supplements, has been recommended for adults and older people by an expert group [**40**]. Evidence to recommend specific interventions is yet to be established.

Key points

- The reported prevalence of sarcopenia in the community is up to 33%, with higher prevalence in long-term and acute care settings.
- This underscores the importance of preventative and clinical management strategies for managing sarcopenia.
- While further research is needed on interventions, we provide recommendations for clinical practice.
- The ISI included representatives of the European Working Group on Sarcopenia in Older People (EWGSOP), the International Working Group on Sarcopenia (IWGS) and international experts.

Conflicts of interest

Abbott had no role in the choice of members of the group, but had the right to have an observer member at the meetings. Members of the Working Group received no salary or other incomes from the European Union Geriatric medicine Society (EUGMS), Abbott Nutrition (AN) or any other

organisation for any of the tasks involved in the preparation of this manuscript or for attending the meetings of the group. An individual COI form has been filled by each member of the International Sarcopenia Initiative group. Medical writing support was provided by Mike Musialowski at Lucid with funding from AN.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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The full list of references is available on Supplementary data available in *Age and Ageing* online, Appendix S3.

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A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities

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Abstract

Background: residential aged care facility (RACF) resident numbers are increasing. Residents are frequently frail with substantial co-morbidity, functional and cognitive impairment with high susceptibility to acute illness. Despite living in facilities staffed by health professionals, a considerable proportion of residents are transferred to hospital for management of acute deteriorations in health. This model of emergency care may have unintended consequences for patients and the healthcare system. This review describes available evidence about the consequences of transfers from RACF to hospital.
Methods: a comprehensive search of the peer-reviewed literature using four electronic databases. Inclusion criteria were participants lived in nursing homes, care homes or long-term care, aged at least 65 years, and studies reported outcomes of acute ED transfer or hospital admission. Findings were synthesized and key factors identified.
Results: residents of RACF frequently presented severely unwell with multi-system disease. In-hospital complications included pressure ulcers and delirium, in 19 and 38% of residents, respectively; and up to 80% experienced potentially invasive interventions. Despite specialist emergency care, mortality was high with up to 34% dying in hospital. Furthermore, there was extensive use of healthcare resources with large proportions of residents undergoing emergency ambulance transport (up to 95%), and inpatient admission (up to 81%).
Conclusions: acute emergency department (ED) transfer is a considerable burden for residents of RACF. From available evidence, it is not clear if benefits of in-hospital emergency care outweigh potential adverse complications of transfer. Future research is needed to better understand patient-centred outcomes of transfer and to explore alternative models of emergency healthcare.

Keywords: *emergency, nursing homes, older people*

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Original article

Comparison of frailty between users and nonusers of a day care center using the Kihon Checklist in Brazil

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ABSTRACT

Background/purpose: Day care centers are rapidly expanding in Brazil to meet the needs of the increasing older population. However, health profiles of their clients remain unclear. Therefore, this study aimed to investigate and compare the health conditions of users and nonusers of a day care center using a new frailty index, the Kihon Checklist.

Methods: This was a cross-sectional observational study. We recruited 59 users (mean age 81.1 ± 6.69 years) and 173 nonusers (mean age 69.9 ± 7.39 years). The nonusers were recruited at a recreational club and municipal health units, and the users were recruited at a day care center for the elderly in Brazil. Measurements consisted of questionnaires regarding sociodemographic and health-related characteristics and the Kihon Checklist.

Results: Compared with the nonusers, users had a higher prevalence of frailty ($p < 0.001$) and impairment of all specific domains (instrumental activities of daily living impairment, $p < 0.001$; physical inactivity, $p < 0.001$; seclusion, $p < 0.001$; cognitive deficit, $p < 0.001$; and depression, $p < 0.001$). The users were also more likely to be frail [odds ratio (OR), 14.226; 95% confidence interval (CI), 5.423–37.320; $p < 0.001$], dependence in instrumental activities of daily living (OR, 78.845; 95% CI, 19.569–317.674; $p < 0.001$), physically inactive (OR, 3.509; 95% CI, 1.467–8.394; $p = 0.005$), cognitively impaired (OR, 5.887; 95% CI, 2.360–14.686; $p < 0.001$), and depressed (OR, 5.175; 95% CI, 2.322–11.531; $p < 0.001$) than the nonusers.

Conclusion: The users of the day care center were frailer than nonusers, especially with regard to independence in instrumental activities of daily living, physical strength, cognitive function, and mood. Health care workers should use the Kihon Checklist to verify frequently the condition of elderly patients to prevent worsening of frailty.

1. Introduction

By 2050, the elderly population in Brazil is projected to represent approximately 30% of the total population, making Brazil one of the countries with the largest absolute number of elderly people worldwide.[1,2] These demographic changes will present a new challenge to the Brazilian health care system.[3]

In this context, noninstitutionalized care modalities that assist frail older persons are emerging in Brazil.[4] One example is day care centers that offer programs designed to meet the needs of elderly persons who require supervised care during the day but can return home in the afternoon or evening. Such institutions are rapidly expanding. However, the health profiles of the day care center attendees and their specific needs remain unclear due to the busy work schedule of the center staffs who do not have time required for the massive assessments for older adults.

Hence, this study sought to (1) investigate health conditions of the users of a day care center using a new frailty assessment tool known as the Kihon Checklist (KCL), a comprehensive and fast questionnaire, and (2) compare health profiles of the day care center users with those of elderly community-dwelling nonusers of such facilities.

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2. Methods

This is a cross-sectional observational study.

2.1. Participants

The inclusion criteria were as follows: community-dwelling adults aged 60 years or older, users or nonusers of day care services, who were able to respond to the questionnaire independently or by proxy. Individuals who did not match these criteria or did not want to participate were excluded. All participants received explanations regarding the research procedures and signed an informed consent form.

The nonusers of day care services were recruited at a recreational club and municipal health units, whereas the users were recruited at a day care center for the elderly with a maximum capacity of 30 participants per day. The prior criterion to attend the center included the need for support to perform daily activities. The center's professional team consists of medical doctors, nurses, physical therapists, social assistants, and volunteers. The main objectives of the institution are to provide proper care to the elderly, offering activities that preserve their dignity, and also to improve the quality of life of the participants and their families. All institutions were private and located in the same city in southern Brazil. Patient recruitment and data collection were carried out from June 2012 to April 2013.

The study protocol was approved by the Ethics Committee at Kyoto University Graduate School of Medicine, Kyoto, Japan (E-1575).

2.2. Assessments

The collected data were as follows: (1) sociodemographic information, including age, gender, living structure, educational level, and working status; (2) health-related characteristics, including body mass index (BMI), use and number of medications, frequency of medical consultation in the past 6 months, hospitalization in the past year, and life satisfaction; and (3) the translated and validated Brazilian Portuguese version of the KCL.[5]

The KCL was developed by the Japanese Ministry of Health, Labor, and Welfare, based on the needs of the Japanese long-term care insurance system. This checklist is used to screen frail older adults and identify those at higher risk of becoming dependent.[6–8] The checklist is a self-administered questionnaire that comprises 25 yes/no questions divided into instrumental activities of daily living (IADLs), physical strength, nutrition, eating, socialization, memory, and mood domains. A higher score indicates a frailer health condition. We determined the following cutoff points: for the KCL total score (sum of the scores of all questions) $\geq$7 points; IADL domain $\geq$3 points; physical domain $\geq$3 points, representing physical inactivity; nutrition domain score = 2 points, indicating malnutrition; additionally in question number 12, regarding body composition in the same domain, we adopted a cutoff of BMI <20.5; oral domain $\geq$2 points, suggesting oral dysfunction; socialization domain $\geq$1 point, representing seclusion; memory domain $\geq$1 point, suggesting cognitive impairment; and finally, mood domain $\geq$2 points, indicating depression. These cutoff points were adopted based on our previous findings that determined the KCL cutoffs associated with an elevated risk of requiring long-term care insurance service.[7,9] The time required to answer the KCL is approximately 15 minutes. Further details of the KCL have been described previously.[5]

2.3. Statistical analysis

Regarding sociodemographic and health-related characteristics, we analyzed the differences in age, BMI, and number of medications between users and nonusers of the day care service using an unpaired *t* test. For categorical variables (i.e., gender, living structure, educational level, working status, use of medication, medical consultation, hospitalization, and life satisfaction), we used the Chi-square test. For the variables that exhibited a significant difference ($p < 0.05$; i.e., living structure, working status, and life satisfaction), we dichotomized each item and conducted a Chi-square analysis separately for each category. Additionally, we analyzed the differences in KCL domains (mean scores) between groups using analysis of covariance (ANCOVA) adjusted for age.

We calculated the differences in the percentage of frail older adults (according to the KCL cutoff points) between the groups using the Chi-square test. We also performed a binary logistic regression analysis adjusted for age and gender, using each KCL domain as a dependent variable. For the total KCL score and for each domain, the robust condition was coded as 0 and frail condition as 1. The nonuser group was the reference group. Finally, to determine the variables with higher influence on day care use, we performed a binary logistic regression analysis (using the stepwise method), adjusted for age and gender, with "use of day care" (nonusers = 0 and users of day care service = 1) as the dependent variable. Dichotomous covariates included were the KCL variables that showed a significance in the previous regression analysis (using the enter method). Statistical significance was set at $p < 0.05$. All analyses were performed using the SPSS (version 21.0, SPSS; IBM Inc., Chicago, IL, USA).

3. Results

3.1. Sociodemographic and health-related characteristics

A total of 232 elderly persons met the criteria for the study (community, $n = 173$, mean age 69.9 $\pm$ 7.39 years; day care, $n = 59$, mean age 81.1 $\pm$ 6.69 years).

Among the 59 users of day care services, 18.6% utilized the day care center once a week, 48.8% twice a week, 25.6% three times per week, 4.7% four times per week, and 2.3% five times per week.

The users of day care services were older, and the majority lived with their children ($p < 0.001$). By contrast, most of the nonusers lived with their partners ($p = 0.017$). Additionally, most of the users were retired ($p < 0.001$), whereas some of the nonusers were still engaged in volunteer activities ($p = 0.044$). Furthermore, the nonusers of day care services had a higher BMI ($p = 0.004$) and were more satisfied with their lives than the users ($p = 0.013$) (Table 1).

3.2. Frailty condition

Differences were identified in the total mean KCL score ($p < 0.001$) and the mean KCL scores for all the domains between the two groups. Even when results for each domain were adjusted for age, the users of day care services were found to be frailer than the nonusers in terms of IADLs ($p < 0.001$), physical strength ($p < 0.001$), nutrition ($p = 0.001$), eating ($p = 0.01$), socialization ($p < 0.001$), memory ($p < 0.001$), and mood ($p < 0.001$) (Table 2).

Based on the results that identified frailty using the cutoff points, we observed that the users had a higher prevalence of frailty according to the total KCL score ($p < 0.001$) than the nonusers. Moreover, the user group contained more participants with IADL impairment ($p < 0.001$), physical inactivity ($p < 0.001$), seclusion ($p < 0.001$), cognitive deficit ($p < 0.001$), and depression ($p < 0.001$) (Table 3).

Results of the logistic regression, adjusted for age and gender, confirmed that the users of day care services were more likely to be frailer than the nonusers. Compared with nonusers, the day care

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Table 1
Sociodemographic and health-related characteristics of nonusers and users of a day care center.

Variables		Nonusers (n = 173) Valid % (n)	Users (n = 59) Valid % (n)	p
Age	Mean ± SD	69.9 ± 7.39	81.1 ± 6.69	<0.001
Gender	Female	73.4 (127)	71.2 (42)	0.740
Living structure				0.005
	Alone	18.5 (32)	11.9 (7)	0.239
	With partner	31.2 (54)	15.3 (9)	0.017
	With child	20.8 (36)	45.8 (27)	<0.001
	With partner and child	23.1 (40)	18.6 (11)	0.473
	Other	6.4 (11)	8.5 (5)	0.467
Educational level				0.117
	Elementary school	42.6 (72)	55.2 (32)	
	Junior high school	13.6 (23)	12.1 (7)	
	High school	13 (22)	10.3 (6)	
	University	26.6 (45)	12.1 (7)	
	Other	4.2 (7)	10.4 (5)	
Working status				0.006
	Formal Work	11.7 (19)	3.4 (2)	0.079
	Informal Work	9.3 (15)	3.4 (2)	0.179
	Volunteer work	10.5 (17)	1.7 (1)	0.044
	Retirement	68.5 (111)	91.5 (54)	<0.001
BMI	Mean ± SD	26.0 ± 4.53	24.0 ± 5.17	0.004
Medication	Yes	82.1 (142)	84.7 (50)	0.640
Number of medications	Mean ± SD	2.65 ± 2.60	3.39 ± 2.53	0.058
Medical consultation (past 6 mo)				0.862
	None	13.6 (23)	15.3 (9)	
	1–2 times	59.2 (100)	59.3 (35)	
	3–4 times	18.3 (31)	20.3 (12)	
	5 times or more	8.9 (15)	5.1 (3)	
Hospitalization (past 12 mo)	Yes	12.8 (22)	15.3 (9)	0.632
Life satisfaction				0.013
	Satisfied	89.6 (155)	78.0 (46)	0.023
	Fair	6.4 (11)	6.8 (4)	0.910
	Unsatisfied	4.0 (7)	15.3 (9)	0.003

BMI = body mass index.

users were several times more likely to be frail [odds ratio (OR), 14.226; 95% confidence interval (CI), 5.423–37.320; $p < 0.001$], IADL dependent (OR, 78.845; 95% CI, 19.569–317.674; $p < 0.001$), physically inactive (OR, 3.509; 95% CI, 1.467–8.394; $p = 0.005$), cognitively impaired (OR, 5.887; 95% CI, 2.360–14.686; $p < 0.001$), and depressed (OR, 5.175; 95% CI, 2.322–11.531; $p < 0.001$) (Table 4).

We observed that among the five KCL variables found to be significant using the logistic regression analysis enter method (i.e., total KCL score, IADLs, physical strength, memory, and mood), only two were significant in the stepwise model: the KCL total score (OR, 5.201; 95% CI, 1.645–16.445; $p = 0.005$) and the IADL domain (OR, 37.368; 95% CI, 8.823–158.262; $p < 0.001$) (Table 5).

Table 2
Differences in the KCL domains' mean scores between users and nonusers of the day care center, adjusted for age.

Variables	Nonusers (n = 173)	Users (n = 59)	p
Total KCL score	4.51 ± 3.62	10.9 ± 3.93	<0.001
IADL domain	0.40 ± 0.69	2.90 ± 1.36	<0.001
Physical domain	1.25 ± 1.15	2.02 ± 1.50	<0.001
Nutrition domain	0.26 ± 0.46	0.47 ± 0.57	0.001
Eating domain	0.79 ± 0.91	1.10 ± 0.85	0.010
Socialization domain	0.30 ± 0.48	0.66 ± 0.66	<0.001
Memory domain	0.67 ± 0.78	1.63 ± 0.87	<0.001
Mood domain	0.87 ± 1.32	2.12 ± 1.39	<0.001

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

Table 3
Frail individuals in the nonuser and user groups, as determined by cutoff points.

	Frail nonusers (n = 173) Valid % (n)	Frail users (n = 59) Valid % (n)	p
Total KCL score	27.2 (47)	88.1 (52)	<0.001
IADL domain	1.7 (3)	72.9 (43)	<0.001
Physical domain	13.9 (24)	37.3 (22)	<0.001
Nutrition domain	0.6 (1)	3.4 (2)	0.118
Eating domain	23.7 (41)	24.1 (14)	0.946
Socialization domain	28.9 (50)	55.9 (33)	<0.001
Memory domain	49.1 (85)	86.4 (51)	<0.001
Mood domain	23.1 (40)	64.4 (38)	<0.001

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

4. Discussion

As expected, the day care center users were generally frailer than the nonusers, as demonstrated by the differences in the total KCL score; additionally, for all specific aspects of health (functional performance in IADLs, physical strength, nutrition, eating, socialization, memory, and mood), users were more impaired than nonusers, as indicated by the KCL domain mean scores.

However, both groups had similar percentages of participants meeting the cutoffs for frailty regarding nutrition and eating conditions; the participants also had a similar risk of malnutrition and oral disability. These findings may be supported by the BMI measures, which indicated that both groups were in the normal weight range. It was interesting to notice that the KCL mean scores differed between groups; however, when the data were categorized according to the cutoff points, no difference was observed between them. Hence, we suggest that both the mean scores and the cutoff points for the KCL should be used when analyzing such type of data. The mean scores can reveal even slight variations in the data, especially when dealing with small sample sizes, whereas the cutoff points can help manage large sample sizes with regard to the aspects of frailty in the analyzed population.

Participants also had a similar risk of seclusion regardless of the use of the day care center, indicating the importance of these centers to meet the social and emotional needs of the elderly, as such centers can alleviate feelings of loneliness, boredom, and solitude.[10]

The logistic regression results indicated that the need variables for Brazilian users of day care services focus on IADL functional independence, physical strength, cognitive function, and mood (Table 4), and this agrees with other research studies where a day care center is an option for disabled older people, who have functional disabilities, cognitive deficits, or mental frailties.[11,12] Moreover, apart from general frailty, the most relevant determinant of day care center use detected by logistic regression was functional impairment in IADLs. Such functional dependence was already

Table 4
Logistic regression analysis (enter method) adjusted for age and gender (n = 232).

Day care center user group	Odds ratio	95% confidence interval	p
Total KCL score	14.2	5.42–37.3	<0.001
IADL domain	78.8	19.6–318	<0.001
Physical domain	3.51	1.47–8.39	0.005
Nutrition domain	0.630	0.035–11.5	0.755
Eating domain	0.734	0.315–1.71	0.473
Socialization domain	1.75	0.822–3.71	0.147
Memory domain	5.89	2.36–14.7	<0.001
Mood domain	5.18	2.32–11.5	<0.001

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

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Table 5
Logistic regression analysis (stepwise method) adjusted for age and gender ($n = 232$).

Day care center user group	Odds ratio	95% confidence interval	p
Total KCL score	5.20	1.65–16.4	0.005
IADL domain	37.4	8.82–158	<0.001

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

stated as one of the criteria for eligibility for long-term care insurance in Japan.[7] Maintaining or enhancing the ability to perform daily activities and preventing dependence are the primary goals in the care of vulnerable older adults.[13]

Difficulties in performing IADLs preclude independent living, requiring support that is typically initially provided by the family. Such findings may be linked with the difference in living structure between the groups, considering that the majority of users lived with their children ($p < 0.001$), who may be their caregiver, whereas the nonusers lived with their partner ($p = 0.017$). In Brazil, the State attributes to the family the major role in home care for the disabled elderly,[3] exposing the family caregiver to high burdens that were frequently associated with physical disability, cognitive decline and functional impairment.[14–16] In this context, the family, as the primary caregiver, often seeks other sources of support to reduce its burden and distress,[17] and these sources include day care centers.

Interestingly, regardless of day care center use, the use and number of medications, frequency of medical consultation, and frequency of hospitalization were similar in both groups. This finding suggests the important role of day care centers from the societal perspective, as they contribute to curtailing national expenditures by delaying or preventing institutionalization, which is much more expensive.[18]

In brief, we identified differences in general health and also in all specific aspects of health between users and nonusers of a day care service center. The users of the day care center were frailer than the nonusers, and were also more likely to be physically and cognitively frail, to be functionally impaired in IADLs, and to have depression. These aspects of frailty do not seem to represent the main needs of elderly clients, but more so the main concerns of the family caregivers because of the heavy burden associated with these aspects. All these negative outcomes may influence life satisfaction, as our findings showed that the users of day care service centers were more unsatisfied with their lives ($p = 0.003$). Therefore, health care workers may use these findings to prevent worsening of frailty, making an effort to improve not only health but also well-being.

We verified these important differences between users and nonusers of day care service centers using only one type of assessment, the KCL, a fast and easy assessment tool that included all the important domains regarding the needs of the elderly. Therefore, we encourage the use of such assessment method as a fast screening tool for frailty in the elderly population; when the KCL results indicate an alarming condition, we suggest continuation and intensification of the investigation using specific instruments for the respective domain.

This study has several limitations related to its cross-sectional design and recruitment locations. As this study was carried out only in one region of Brazil, the results cannot be generalized to a national population. Additionally, the study included only one day care center. Moreover, we address the possible selection bias that may have occurred considering the predictable higher percentage of frailty in day care center user group; however, recruiting day care center users was the unique methodology to achieve the purpose of the present study. Further studies including more participants and institutions from different regions of Brazil are warranted.

Conflicts of interest

The authors declare no potential conflicts of interest.

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Review

Sarcopenia in Asia: Consensus Report of the Asian Working Group for Sarcopenia

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ABSTRACT

Sarcopenia, a newly recognized geriatric syndrome, is characterized by age-related decline of skeletal muscle plus low muscle strength and/or physical performance. Previous studies have confirmed the association of sarcopenia and adverse health outcomes, such as falls, disability, hospital admission, long term care placement, poorer quality of life, and mortality, which denotes the importance of sarcopenia in the health care for older people. Despite the clinical significance of sarcopenia, the operational definition of sarcopenia and standardized intervention programs are still lacking. It is generally agreed by the different working groups for sarcopenia in the world that sarcopenia should be defined through a combined approach of muscle mass and muscle quality, however, selecting appropriate diagnostic cutoff values for all the measurements in Asian populations is challenging. Asia is a rapidly aging region with a huge population, so the impact of sarcopenia to this region is estimated to be huge as well. Asian Working Group for Sarcopenia (AWGS) aimed to promote sarcopenia research in Asia, and we collected the best available evidences of sarcopenia researches from Asian countries to establish the consensus for sarcopenia diagnosis. AWGS has agreed with the previous reports that sarcopenia should be described as

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low muscle mass plus low muscle strength and/or low physical performance, and we also recommend outcome indicators for further researches, as well as the conditions that sarcopenia should be assessed. In addition to sarcopenia screening for community-dwelling older people, AWGS recommends sarcopenia assessment in certain clinical conditions and healthcare settings to facilitate implementing sarcopenia in clinical practice. Moreover, we also recommend cutoff values for muscle mass measurements (7.0 kg/m^2 for men and 5.4 kg/m^2 for women by using dual X-ray absorptiometry, and 7.0 kg/m^2 for men and 5.7 kg/m^2 for women by using bioimpedance analysis), handgrip strength (<26 kg for men and <18 kg for women), and usual gait speed (<0.8 m/s). However, a number of challenges remained to be solved in the future. Asia is made up of a great number of ethnicities. The majority of currently available studies have been published from eastern Asia, therefore, more studies of sarcopenia in south, southeastern, and western Asia should be promoted. On the other hand, most Asian studies have been conducted in a cross-sectional design and few longitudinal studies have not necessarily collected the commonly used outcome indicators as other reports from Western countries. Nevertheless, the AWGS consensus report is believed to promote more Asian sarcopenia research, and most important of all, to focus on sarcopenia intervention studies and the implementation of sarcopenia in clinical practice to improve health care outcomes of older people in the communities and the healthcare settings in Asia.

Sarcopenia has been accepted as a new geriatric syndrome,[1] and the knowledge related to sarcopenia is growing rapidly worldwide. Over the past 20 years of sarcopenia research after the first introduction by Rosenberg et al,[2] the etiology, pathophysiology, risk factors, and consequences of sarcopenia have gradually become clearer.[3] Moreover, a number of therapeutic approaches and clinical trials have been developed and are still evolving.[4–7] Most importantly, the association of sarcopenia with poorer health status and adverse outcomes had triggered a new approach for health promotion and health care of older people. The escalation of elderly population worldwide further strengthened the clinical importance of sarcopenia, which is even more significant in Asia because of the rapid demographic transition in this highly populated continent.[8–10]

Sarcopenia has been described as an age-related decline in skeletal muscle mass as well as muscle function (defined by muscle strength or physical performance),[11] which may result in reduced physical capability,[12–14] poorer quality of life, impaired cardiopulmonary performance,[15,16] unfavorable metabolic effects,[17] falls,[18] disability, and mortality in older people,[19,20] as well as high health care expenditure.[21] Furthermore, sarcopenia is also associated with multimorbidity,[22,23] cigarette smoking,[22,24] low body mass index,[25] underweight,[26] physical inactivity,[12] and low serum levels of testosterone in men.[27,28] In general, the association between sarcopenia and functional decline is more significant in men than in women,[29,30] which deserves further research for therapeutic consideration. Since Asia is the most populated and fastest aging region in the world, sarcopenia will pose great impacts to Asian populations in the near future.[31,32] Therefore, experts and researchers of sarcopenia from China, Hong Kong, Japan, South Korea, Malaysia, Taiwan, and Thailand organized the Asian Working Group for Sarcopenia (AWGS) and had several meetings in Taipei, Seoul, and Kyoto to promote further research development of sarcopenia in Asia since March 2013. This article will focus on the epidemiology of sarcopenia in Asian countries and to propose a diagnostic algorithm based on currently available evidence in Asia.

Diagnosis of Sarcopenia and Its Impact to Asia

Asia is a huge and densely populated continent with a wide range of ethnicities, cultural, social, religious backgrounds, and lifestyles. Because of the rapid population aging and the population size, the impact of sarcopenia in Asia may be stronger than in other continents. However, the status of population aging and economic development varies extensively in different Asian countries. Therefore, developing a consensus for sarcopenia diagnosis and clinical approaches based on available evidence is of great importance for sarcopenia research in the future.

In 2010, European Working Group on Sarcopenia in Older People (EWGSOP) proposed an operational definition and diagnostic strategy for sarcopenia that had become the most widely used in the world.[33] The EWGSOP definition required measurements of muscle mass, muscle strength, and physical performance for the diagnosis of sarcopenia, which is compatible with current understanding about sarcopenia. Based on the discussion of the AWGS meetings, we decided to take similar approaches for sarcopenia diagnosis, but unlike EWGSOP, we recommended measuring both muscle strength (handgrip strength) and physical performance (usual gait speed) as the screening test (Figure 1). Although the recommended approaches for measurements of muscle mass, muscle strength, and physical performance by AWGS were similar to the EWGSOP definition, the cutoff values of these measurements in Asian populations may differ from those in Caucasians because of ethnicities, body size, lifestyles, and cultural backgrounds. Therefore, developing an Asian consensus in sarcopenia diagnosis based on the evidence derived from Asian populations is essential for research and therapeutic approaches to sarcopenia in Asia.

Strategy for Sarcopenia Screening and Assessment

In principle, AWGS followed the diagnostic approach of EWGSOP, and we added some Asian perspectives in sarcopenia diagnosis and research. In the previous studies from Western countries, the prevalence of sarcopenia in older people was around 20% among people aged 65 years and older and may reach 50%–60% in octogenarians.[34] EWGSOP recommends routine screening for sarcopenia among community-dwelling people aged 65 years and older. On the other hand, the International Working Group on Sarcopenia (IWGS) specifies certain conditions for sarcopenia assessment, including (1) noted decline in function, strength, "health" status, (2) self-reported mobility-related difficulty, (3) history of recurrent falls, (4) recent unintentional weight loss (>5%), (5) post-hospitalization, and (6) other chronic conditions (eg, type 2 diabetes, chronic heart failure, chronic obstructive pulmonary disease, chronic kidney disease, rheumatoid arthritis, and cancer).[35] Moreover, IWGS recommends assessing patients with reduced physical functioning (or weakness) or patients with habitual gait speed <1.0 m/s (by 4-m course) to assess body composition by dual x-ray absorptiometry (DXA). Nonambulatory patients or those who cannot rise from a chair unassisted should be considered to be sarcopenic without DXA measurements. Since sarcopenia is defined as an age-related condition, assessment of sarcopenia is limited to people aged 65 years and older only in the

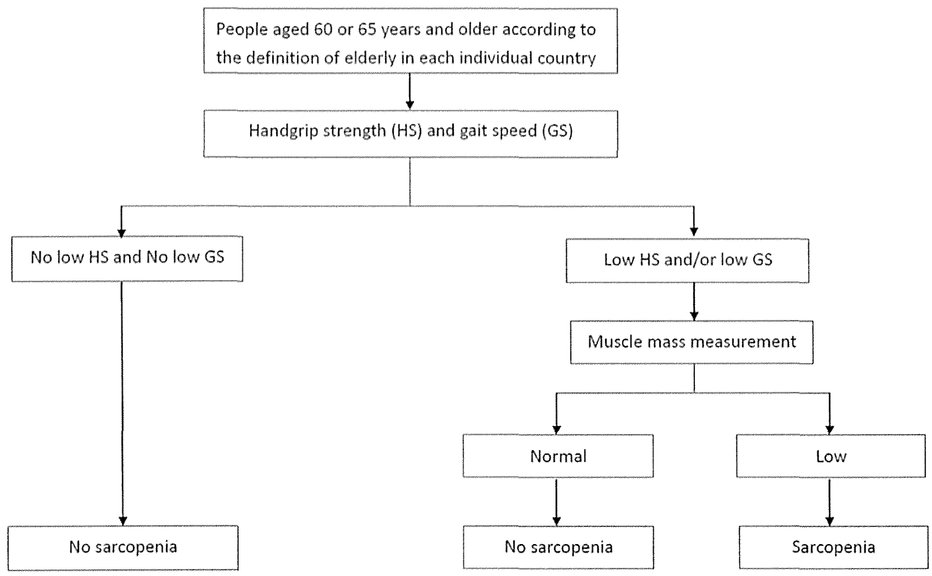

Fig. 1. Recommended diagnostic algorithm of Asian Working Group for Sarcopenia.

EWGSOP criteria, but IWGS does not specify the age for sarcopenia diagnosis.

In Asia, because of the different states of aging, not all countries use the same age cutoff to define elderly populations. Therefore, AWGS recommends using 60 or 65 years as the age for sarcopenia diagnosis according to the definitions of elderly in each country. Although muscle aging is a continuous process, most previous studies supported the idea that loss of muscle mass and muscle strength becomes pronounced around the age of 50,[36] progresses faster after the age of 60,[37] and accelerates even faster after the age of 75.[38] The overall benefits of sarcopenia screening or assessment programs are dependent on the outcomes of effective intervention programs. AWGS emphasizes the benefits of intervention programs in addition to sarcopenia screening and assessment; therefore, we recommend screening for sarcopenia among community-dwelling older people as well as older people with certain clinical conditions in all healthcare settings. Table 1 summarized the recommended strategy for sarcopenia screening and assessment of AWGS by dividing cases into 2 categories (ie, community settings and specific chronic conditions in all healthcare settings). From the perspective of public health, sarcopenia screening for community-dwelling older people would facilitate health promotion and disability prevention in their communities, and the assessment of sarcopenia in clinical settings would facilitate strategies for the intervention in clinical practice. AWGS would like to emphasize the prognostic significance of sarcopenia in clinical practice through assessment under certain clinical conditions. However, the benefits of identification of and interventions for sarcopenia remain to be determined.

Table 1
Strategy of Sarcopenia Screening and Assessment for Older People (60 or 65 Years of Age and Older) in Asia

Community Settings
People aged 60 or 65 years and older (according to the definitions of elderly in each individual country) living in communities
Specific Clinical Conditions in All Healthcare Settings
Presence of recent functional decline or functional impairment
Unintentional body weight loss for over 5% in a month
Depressive mood or cognitive impairment
Repeated falls
Undernutrition
Chronic conditions (eg, chronic heart failure, chronic obstructive pulmonary disease, diabetes mellitus, chronic kidney disease, connective tissue disease, tuberculosis infection, and other chronic wasting conditions)

Suggested Outcome Indicators in Sarcopenia Research

The EWGSOP definition suggests using physical performance, muscle strength, and muscle mass as the primary treatment outcome indicators for sarcopenia intervention trials, whereas activities of daily living, quality of life, metabolic and biochemical markers, inflammatory markers, global impression of change by subject or physician, falls, admission to nursing home or hospital, social support, and mortality as secondary outcome indicators.[33] While most epidemiologic studies in sarcopenia research to date have taken a static approach, the state of sarcopenia may change over time and this dynamic approach may provide different considerations in developing sarcopenia intervention programs. Therefore, AWGS also recommends a dynamic approach for sarcopenia research by measuring changes in (1) muscle mass, strength, and function, (2) physical performance, (3) frailty status, (4) instrumental activities of daily living, and (5) basic activities of daily living over a given period of time as outcome indicators for sarcopenia research. In addition to the above-mentioned outcome indicators, AWGS also recommends using fear of falling and incontinence as outcome indicators for sarcopenia research (Table 2).

Assessment Techniques and Suggested Cutoff Values

Assessment of sarcopenia in Asian populations presents a great challenge because of the lack of outcome-based studies. However, determining appropriate cutoff values for sarcopenia diagnosis in Asia is critical to promote further sarcopenia research and treatment in Asia. Consequently, AWGS focused on the best available evidence to determine cutoff values for the diagnosis of sarcopenia in Asia. If, however, no outcome-based data are available, AWGS would recommend standardized approaches for cutoff value determination.

Table 2
Outcome Indicators for Sarcopenia Research Recommended by AWGS

Static Approach
Activities of daily living
Quality of life
Inflammatory markers
Falls
Frailty status
Mobility disorders
Admission to hospitals
Admission to long term care facilities
Mortality
Dynamic Approach
Changes in muscle mass
Changes in muscle strength
Changes in physical performance
Changes in frailty status
Changes in instrumental activities of daily living
Changes in activities of daily living

AWGS, Asian Working Group for Sarcopenia.

Muscle Mass

EWGSOP recommends DXA, computed tomography (CT), magnetic resonance imaging (MRI), and bioimpedance analysis (BIA) for sarcopenia research. Currently, the precision of DXA, CT, and MRI has been well recognized, but the precision of BIA in measuring muscle mass is controversial. BIA was developed to estimate the volume of body fat and lean body mass, but not appendicular muscle mass. Although the accuracy of BIA in sarcopenia diagnosis has been validated,[39–41] it is heavily dependent on the accuracy of the equation of the equipment and the conditions of assessments, eg, temperature, humidity, skin condition, etc.[42] Nevertheless, the high cost, CT-generated radiation exposure, and inconvenience for community screening have limited the applications of CT and MRI despite both CT and MRI have both been considered gold standards for evaluation of body composition. On the other hand, DXA is also considered an appropriate alternative approach to distinguish between fat, bone mineral, and lean tissues. Currently, DXA may be the most widely used method for muscle mass measurement in sarcopenia research. Despite the minimal radiation exposure from DXA, using DXA in community screening of sarcopenia is still difficult. Newly developed models of BIA equipment may obtain measurements of appendicular muscle mass with precision.[43,44] Portability, reasonable cost, fast processing, noninvasiveness, radiation-free functions, and convenience of use made BIA suitable for community sarcopenia assessment. Results of multiple segment fat-free mass estimation using BIA are highly associated with that measured using DXA among elderly Taiwanese.[45] Although using BIA equipment with validated equations is recommended for sarcopenia research in EWGSOP criteria, the equations of BIA equipment in Western countries are not derived from Asian populations. Strasser et al[46] proposed measurement of muscle thickness, especially of musculus vastus medialis, by musculoskeletal ultrasound to be a reliable method for the estimation of sarcopenia, which deserves further research for applications in Asian studies. In current Asian studies, the most commonly used BIA machines were manufactured by only 2 companies, and the results were quite consistent. Because of its portability and reasonable cost, BIA may be considered the main approach in sarcopenia assessment in community-based screening programs. Therefore, AWGS supports using BIA for sarcopenia diagnosis and evaluation of the effect of intervention programs, but AWGS suggests researchers to provide coefficient of variance, inter- and intra-examiner reliability whenever possible to facilitate subsequent international comparisons.

In terms of cutoff value determination, most current Asian studies have adopted the classical approach for muscle mass measurement (ie, below 2 standard deviations of the mean muscle mass of young adults). However, Asian studies reported an extremely low prevalence of sarcopenia through this approach, especially in older women.[26,47,48] Lau et al[26] also found that the relative total skeletal muscle of Hong Kong Chinese (total skeletal muscle /height^2) was 17% lower among young Chinese men than that of Caucasian men.[26] A potential cohort effect may exist in this approach since younger people in Asia today leading a westernized or more urbanized lifestyle while older Asian people have carried out a traditional lifestyle since adulthood. This cohort effect may be derived from the economic development, urbanization, and development of public transportation in Asia in recent decades. Older Asian people today may have walked and performed more physical activities because of the underdevelopment of public transportation and living conditions since their early adulthood, so their muscle mass may be maintained better than that of the younger generation. On the other hand, because of the relatively higher adiposity of Asian people in comparison with Caucasians, appendicular muscle mass may be overestimated by DXA. Overall, AWGS recommends using 2 standard deviations below the mean muscle mass of young reference group or the lower quintile as the cutoff value determination. Moreover, AWGS recommends using height-adjusted skeletal muscle mass instead of weight-adjusted skeletal muscle mass, and the suggested cutoff values were 7.0 kg/m^2 in men and 5.4 kg/m^2 in women by using DXA. By using BIA, the suggested cutoff values were 7.0 kg/m^2 in men and 5.7 kg/m^2 in women, defined by appendicular skeletal muscle mass/height^2.

Muscle Strength

Measuring handgrip strength is considered a feasible and convenient measure of muscle strength because of cost, availability, ease of use, and its association with leg strength. Wu et al[49] presented the norm of handgrip strength in Taiwan, which disclosed that the mean grip strength of the study sample in Taiwan was significantly lower (male 25%, female 27%) than consolidated norms derived from largely Caucasian populations. Although some papers published in Taiwan using this adjusted cutoff value based on EWGSOP definition for sarcopenia research,[50] some unpublished papers from Japan, Hong Kong, and China recommended using 25 kg for men and 18 or 16 kg for women as the cutoff values for handgrip strength. Currently, handgrip strength is the most widely used measure for muscle strength in Asian sarcopenia research (Table 3), and AWGS also recommends using it for the measurement of muscle strength. Although knee flexion/extension and peak expiratory flow are also recommended for sarcopenia research in EWGSOP criteria, they are less commonly used. In Thailand, the cutoff points of quadriceps strength had been defined based on the outcome of mobility decline. The cutoff points of <18 kg in men and <16 kg in women can discriminate those had normal and abnormal various sarcopenia-related variables. Because of the lack of outcome-based cutoff values, AWGS recommends using the lower 20th percentile of handgrip strength of the study population as the cutoff value for low muscle strength before outcome-based data is available. Low handgrip strength is suggested to be defined as <26 kg for men and <18kg for women by AWGS.

Physical Performance

A wide range of tests for physical performance are recommended in EWGSOP criteria, including the Short Physical Performance Battery (SPPB), usual gait speed, the 6-minute walk test, the stair climb power test, and the timed-up-and-go test (TUG).[51] Timed usual gait is highly predictive for the onset of disability,[52] and other adverse health

Table 3
Measurable Variables and Cutoff Points in Asian Populations

Criterion	Measurement Method	Cutoff Points by Sex	Reference Group Definition	Prevalence of Sarcopenia	Country/ Ethnicity	Reference
Muscle mass	DXA	ASM/height^2 Class 1 and class 2 sarcopenia Men: 7.77 and 6.87 kg/m^2 Women: 6.12 and 5.46 kg/m^2	Based on values 1 and 2 SD below the sex-specific means of the study reference data (n = 529)	Class 1 and class 2 sarcopenia in subjects 70–85 years of age: Men: 6.7%, 56.7% Women: 6.3%, 33.6%	Japan	69
		ASM/height^2 Men <5.72 kg/m^2 Women <4.82 kg/m^2	Based on 2 SD below the mean of young Asians in study (n = 111)	In older Chinese ≥70 years of age Men: 12.3% Women: 7.6%	Chinese	26
		ASM/height^2 Men: 7.40 kg/m^2 Women: 5.14 kg/m^2	Based on 2 SD below the sex-specific mean of a younger population (n = 145)	In older subjects ≥ 60 years of age Men: 6.3% Women: 4.1%	Korea	70
		SMI (%)† Men: 35.71% Women: 30.70%	Based on 2 SD below the sex-specific mean of a younger population (n = 145)	Men: 5.1% Women: 14.2%		
		Using the residuals method		Men: 15.4% Women: 22.3%		
		ASM/height^2 Class I and class II sarcopenia Men: 7.50 and 6.58 kg/m^2 Women: 5.38 and 4.59 kg/m^2	Based on 1 and 2 SD below the mean of young adults in study (n = 2513)	Class I and class II sarcopenia Men: 30.8% and 12.4% Women: 10.2% and 0.1%	Korea	48
		ASM/body weight (%) Class I and class II sarcopenia Men: 32.2% and 29.1% Women: 25.6% and 23.0%	Based on 1 and 2 SD below the mean of young adults in study	Men: 29.5% and 9.7% Women: 30.3% and 11.8%	Korea	48
		ASM/body weight (%)‡ Men: 29.53% Women: 23.20%	Based on 2 SD of sex-specific young normal people		Korea	71
		Use SMI (% of skeletal muscle index) but not mentioned the cutoff points in the manuscript	Based on 2 SD of sex-specific young normal people	Sarcopenia class I, II, overall Men: 32.5%, 15.7%, 35.33 % Women: 30.5%, 10%, 34.74 %	Thailand	72
		RASM index Men: 7.27 kg/m^2 Women: 5.44 kg/m^2	Based on the lower 20% of study group	Men: 10.8% Women: 3.7%	Taiwan	47
		SMI (% of skeletal muscle index) Men: 37.4% Women: 28.0%	Based on the lower 20% of study group	Men: 14.9% Women: 19%		
	BIA	SMI Men <8.87 kg/m^2 Women <6.42 kg/m^2	Based on 2 SD below the normal sex-specific mean for young people	18.6% in elderly women and 23.6% in elderly men age 65 and older	Taiwan	40
		ASM/height^2 Men <7.0 kg/m^2 Women <5.8 kg/m^2	Based on 2 SD below young adult values	Men: 11.3% Women: 10.7% using EWGSOP criteria	Japan	13
		ASM/height^2 Women ≤ 6.42 kg/m^2		Women: 22.1%	Japan	6
		ASM/height^2 Men <6.75 kg/m^2 Women <5.07 kg/m^2	Based on 2 SD below young adult values	Men: 21.8% Women: 22.1% using EWGSOP criteria	Korea/Health ABC data	15
Muscle strength	Handgrip strength	Men: 30.3 kg Women: 19.3 kg	Based on lowest quartile of study group		Japan	13
		Men <22.4 kg Women <14.3 kg	Based on EWGSOP recommendation and adjusted according to Asian data[49]		Taiwan	50
	Knee extension	Women ≤1.01 Nm/kg			Japan	6,73
Physical performance	Gait speed	Gait speed Men <1.27 m/s Women <1.19 m/s	Based on the lowest quartile of study group, gait speed obtained from the middle 5 m of a total of 11 m walking	Men: 11.3% Women: 10.7% using EWGSOP criteria	Japan	13
		Gait speed ≤ 1 m/s			Taiwan	50
		Gait speed ≤ 1.22 m/s		Women: 22.1%	Japan	6,73
	SPPB	SPPB scores <9			Korea	74

ASM, appendicular skeletal muscle mass; BIA, bioimpedance analysis; DXA, dual x-ray absorptiometry; EWGSOP, European Working Group on Sarcopenia in Older People; Health ABC, The Health Aging and Body Composition Study; RASM, relative appendicular skeletal muscle; SD, standard deviation; SPPB, Short Physical Performance Battery; SMI, skeletal muscle mass index.

†SMI (%) = total skeletal muscle mass (kg)/weight (kg) × 100.

‡The author also named it modified skeletal muscle mass index (SMI).

events like severe mobility limitation and mortality.[53] TUG is an assessment of ambulation and dynamic balance. Poorer TUG has been demonstrated to be associated with poorer physical and mental function and mood status, as well as low fat-free mass by BIA measurements.[54] Although TUG has been proposed as a suitable measurement for physical performance in EWGSOP, abnormal TUG may result from a great variety of underlying conditions. AWGS is more conservative in the use of TUG as a measurement for physical performance, and we recommend using 6-meter usual gait speed for measurement of physical performance.

Ideally, determination of the cutoff values of these measurements should be based on longitudinal outcome-based studies instead of a simply statistical approach.[55] Although the association between sarcopenia and functional decline or even mortality has been established,[56] selection of universal outcome indicators in subsequent research may facilitate international comparisons. Table 3 summarized the epidemiology and proposed cut-off points in different cases of Asian sarcopenia research. EWGSOP has developed a suggested algorithm based on gait speed measurement with a cutoff point of <0.8 m/s.[33] The association of slow usual gait speed in the elderly with adverse clinical outcomes has been reported extensively, but the application was also dependent on the determination of appropriate cutoff points. Meanwhile, the prevalence of low muscle mass in the Asian population as determined using the classical approach is very low, which is confusing. The potential cohort effect may partially explain the phenomenon of older people today engaging in more physical activities than younger people, which made the prevalence of sarcopenia lower than expected. Specific consideration of this potential cohort effect deserves further attention in the diagnosis of sarcopenia in Asia. Although there is a potential gender difference in the cutoff value of usual gait speed and a wide range of walking speed (from 0.6 to 1.2 m/s) being reported in this special issue, AWGS suggested using ≤0.8 m/s as the cutoff for low physical performance after extensive consideration of data available in Asian studies.

Therapeutic Implications

Physical activities, including aerobics, endurance exercise,[57] and resistance exercise training[58,59] have been demonstrated to significantly increase muscle mass and strength in sarcopenic older people. Although the recommended frequency of exercise training to improve muscle strength and functional performance has been shown,[60] a consensus has not yet been reached concerning the content of the prescribed exercise and the most optimal frequency and intensity. Inappropriate exercise training in the elderly may result in unfavorable adverse outcomes such as musculoskeletal complaints,[61] which is not uncommon. Further research should be focused on the development of suitable exercise prescription, especially for older people at risk of functional decline or sarcopenia. The Society for Sarcopenia, Cachexia, and Wasting Disease developed nutritional recommendations for the prevention and management of sarcopenia, which combined exercise with adequate protein and energy intake.[62] A leucine-enriched balanced essential amino acid or balanced amino acid supplementation is suggested for sarcopenia. Recently, Kim et al[6] demonstrated that exercise and amino acid supplementation (3 g of a leucine-rich essential amino acid mixture twice a day) together may actually be effective in enhancing muscle strength, variables of muscle mass, and walking speed in sarcopenic women. Aside from exercise and nutritional supplementation, the pharmaceutical approach to sarcopenia is still under development. Growth hormone replacement was not successful because the effect of increased muscle mass by growth hormone replacement was not associated with the improvement of muscle performance,[63–65] unless it is used for growth hormone deficiency patients for a period longer than 12 months.[66–68] In addition, the effects of antimyostatin antibodies on sarcopenia have been demonstrated and may be marketed in a few years. Therefore, sarcopenia should be treated through a multilevel approach employing combined physical activities and nutritional supplementation. Currently, there is no well-established evidence for pharmaceutical approach for sarcopenia intervention, but a few agents may be available in future.

Future Challenge and Conclusion

Sarcopenia significantly impacts daily activities, functional status, disability, and quality of life in older populations. Although Asian populations are rapidly ageing, from the clinical practice or public health points of view, the understanding of and preparation for sarcopenia remain inadequate. Hence, this consensus collected as many Asian studies as possible and offers a working diagnosis of sarcopenia for Asian people. The main aims of AWGS were to promote sarcopenia research in Asian countries through providing recommended diagnostic strategies and cutoff values based on Asian studies, and to foster the importance of implementing sarcopenia in clinical practice and in community health promotion programs.

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