J Nutr Health Aging. 2020;24(1):83-90

© Serdi and Springer-Verlag International SAS, part of Springer Nature

DIFFERENCES IN THE PREVALENCE OF SARCOPENIA IN COMMUNITY-DWELLING, NURSING HOME AND HOSPITALIZED INDIVIDUALS. A SYSTEMATIC REVIEW AND META-ANALYSIS.

S.K. PAPADOPOULOU[1], P. TSINTAVIS[1], P. POTSAKI[1], D. PAPANDREOU[2]

1. Dpt of Nutritional Sciences and Dietetics, International Hellenic University, Thessaloniki, Greece; 2. Department of Health Sciences, CNHS, Zayed University, AbuDhabi, United Arab Emirates. Corresponding author: Dimitrios Papandreou, PhD, M.Ed, MS, RDN, Professor of Nutrition and Dietetics Department of Health Sciences, CNHS, Abu Dhabi, UAE, Email: Dimitrios.papandreou@zu.ac.ae

Abstract: *Background:* Sarcopenia is an age-related disease which leads to a decline in muscle mass and function and is one of the most important health issues in elderly people with a high rate and variety of adverse outcomes. *Objective:* The current systematic review and meta-analysis study was carried out to estimate the overall prevalence of sarcopenia in both males and females in different regions around the world and to show the major differences in its occurrence among different populations. *Design:* A systematic review and meta-analysis of studies published in PubMed (Medline) and Scopus. *Participants:* Community dwelling, nursing home and hospitalized older adults aged over 60 years. *Measurements:* Sarcopenia was defined by the major validated diagnostic criteria, such as the European Working Group on Sarcopenia in Older People (EWGSOP), the Asian Working Group for Sarcopenia (AWGS) and the International Working Group on Sarcopenia (IWGS). The model used was the random effect model for estimating the prevalence of sarcopenia. The sex-specific prevalence of sarcopenia as well as 95% CI (Confidence interval) were calculated using MetaXL (version 5.3). Heterogeneity assessment was carried out by subgroup analysis. *Results:* We included 41 studies with a total of 34955 participants. The prevalence of sarcopenia in community-dwelling individuals in the included studies were 11% (95% CI: 8-13%) in men and 9% (95% CI: 7-11%) in women. The prevalence of sarcopenia in nursing-home individuals in the included studies were 51% (95% CI: 37-66%) in men and 31% (95% CI: 22-42%) in women and in hospitalized individuals were 23% (95%, CI: 15-30%) in men and 24% (95% CI: 14-35%) in women. *Conclusions:* Despite the differences encountered between the studies, regarding diagnostic tools used to measure of muscle mass, different regions around the world and different populations and clinical settings, this systematic review revealed that a significant proportion of old people has sarcopenia (major in nursing homes), even in populations healthy in general. However, sarcopenia is caused by the aging progress, early diagnosis and individualized care, including physical activity and nutrition, can prevent some adverse outcomes in all populations.

Key words: Sarcopenia, nursing home, elderly, reduced muscle mass.

Background

Sarcopenia is a geriatric syndrome associated with ageing that is characterized by a loss of muscle function and a progressive loss of skeletal muscle mass. It is known to increase the risk of disability, falls and fall-related injuries, loss of independence, hospitalization, and mortality (1). Characteristics of the population in study (such as age, sex, race and body composition differences in ethnic groups), living situation (hospitalized, community-dwelling and living in nursing homes) and the used methodology to assess sarcopenia's parameters cause a significant variation in the rate of this disease.

In order to improve the early recognition, diagnosis, and management of sarcopenia, as well as to stimulate further research, there have been published several guidelines. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP) introduced the first and most popular consensus, which suggested cut-offs of muscle mass, muscle strength, and physical performance for assessing and diagnosing sarcopenia (2). In 2011, the International Working Group on Sarcopenia (IWGS) published a consensus similar to that of the EWGSOP (3). The American Foundation for the National Institutes of Health (FNIH) Sarcopenia Project published their official consensus in 2014 (4). As a result of differences in ethnicity, genetic background, and body size, the EWGSOP and IWGS criteria might not apply to Asians (5); therefore, sarcopenia experts and scientists from Taiwan, Japan, Hong Kong, South Korea, China, Malaysia, and Thailand established the Asian Working Group for Sarcopenia (AWGS), which published guidelines for diagnosing sarcopenia in 2014 (6).

It is worth mentioning that in early 2018, the Working Group met again (EWGSOP2) to update the original definition in order to reflect scientific and clinical evidence that has built over the last decade. The new consensus (1) focuses on low muscle strength as a key characteristic of sarcopenia, uses detection of low muscle quantity and quality to confirm the sarcopenia diagnosis, and identifies poor physical performance as indicative of severe sarcopenia; (2) updates the clinical algorithm that can be used for sarcopenia case-finding, diagnosis and confirmation, and severity determination and (3) provides clear cut-off points for measurements of variables that

Received July 13, 2019
Accepted for publication August 8, 2019
Published online October 3, 2019, http://dx.doi.org/10.1007/s12603-019-1267-x

identify and characterize sarcopenia (3).

Because of the different measurement tools, cutoff points and sarcopenia criteria, prevalence results may be difficult to interpret. In addition, the major differences in the prevalence of sarcopenia according to the population (community dwelling, hospitalized and living in nursing homes), makes it more difficult to establish preventative routines and therapeutic protocols and it requires a more personalized approach.

This meta-analysis aims to show the variations in the prevalence of sarcopenia in adults aged 60 years according to different populations (community-dwelling, hospital, nurse homes) and to provide awareness of such a serious, multifactorial and often undiagnosed disorder (3).

Methods

The pre-defined review protocol was registered prospectively with the International Prospective Register of Systematic Reviews (PROSPERO—registration number: CRD42019130570).

Search Strategy

The search was carried out in the electronic database of PubMed (Medline) and Scopus between January 2009 and January 2019. The pre-defined search terms were: "sarcopenia" and "prevalence" or "frequency" or "incidence" or "muscle strength" or "muscle mass" or "muscle wasting". The list of references of articles was also reviewed for any additional papers. Search was not limited by language.

Inclusion and Exclusion Criteria

We included only studies that had enrolled participants aged 60 years and older within well-defined populations (such as those in community-dwelling, hospital and nursing home/ geriatric settings). We included studies that prevalence of sarcopenia had been assessed according to the EWGSOP, AWGS or IWGS definitions of sarcopenia, i.e. based on muscle mass (adjusted appendicular muscle mass for height) and muscle strength (handgrip strength) or physical performance (the usual gait speed). We excluded studies that focused on patients with diseases, such as cancer patients and hemodialysis patients.

Research papers were selected based on titles and abstracts. The full texts of all chosen publications were assessed for pertinence. The process initially performed by two investigators. A third investigator adjudicated discrepancies between the two reviewers.

Data Extraction

Two reviewers extracted the information from all studies included using an excel form that we developed using a modified STROBE checklist. The following information was included: study design and methods, country, number of study settings, diagnostic criteria of sarcopenia, study outcomes, the prevalence of sarcopenia, results and conclusions. Another reviewer verified the extracted information.

Statistical Analysis

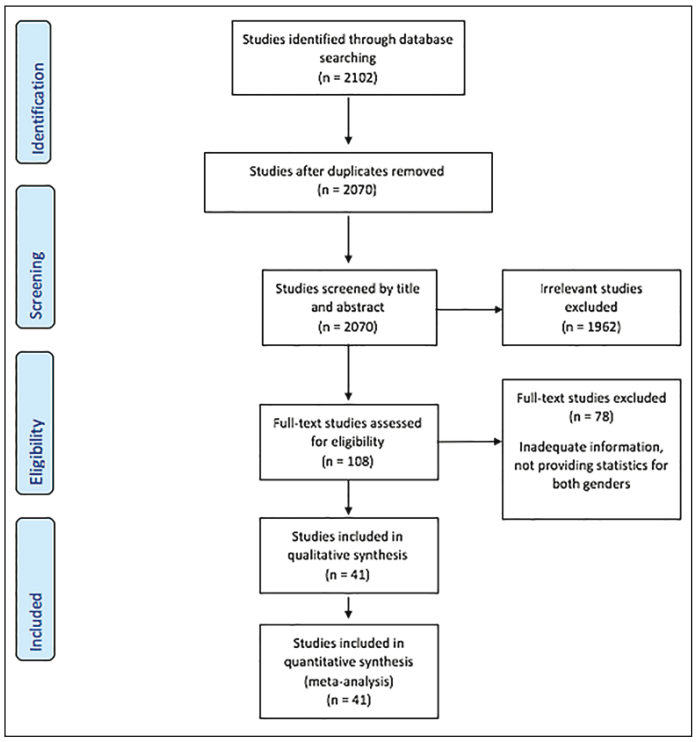
The pooled prevalence of sarcopenia with 95% confidence intervals (CIs) was estimated using a random effects model.

Heterogeneity was assessed by subgroup analysis. Severe heterogeneity was indicated as the heterogeneity of studies was greater than 50%. Publication bias was assessed using Doi plots. All meta-analysis methods were performed using MetaXL 5.3.

Results

The literature searches yielded 2102 studies (including 32 duplicates). According to inclusion criteria, we assessed titles and abstracts and 108 studies were selected. After reviewing full texts, 41 studies were suitable for the meta-analysis (Figure 1).

Figure 1
PRISMA diagram for study selection

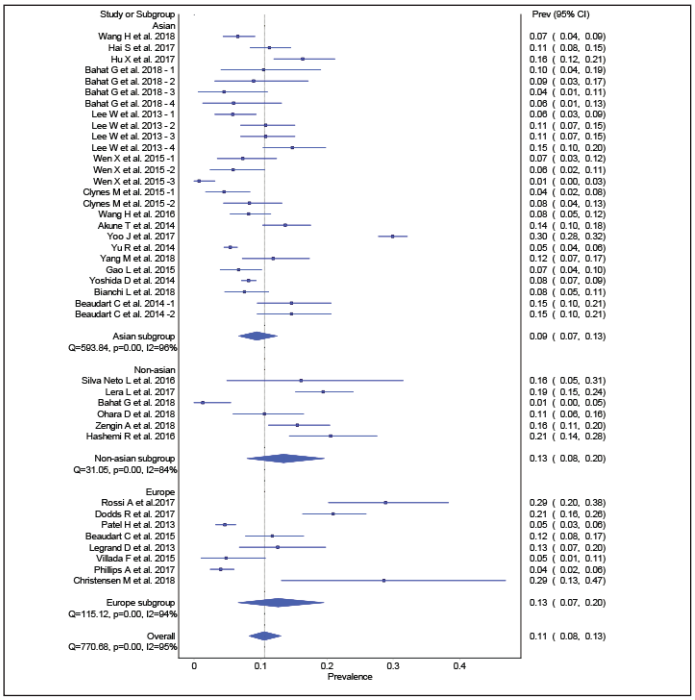


A total of 34955 individuals, 15599 (45%) men and 19347 (55%) women; respectively, from the general population were examined through these studies. 30287 individuals were community-dwelling individuals, whereas 3802 and 886 individuals were from hospitals and nursing homes accordingly. Thirteen studies were distributed in Asia and there were also 28 studies from non-Asian countries, 21 of them being from

Europe. A total of 15 studies used the Dual Energy X-Ray Absorptiometry (DXA) to assess muscle mass, 21 studies used the Bio-electrical Impedance Analysis (BIA) and 6 studies used anthropometric equations. In a study both DXA and BIA were used to assess muscle mass (7). The PRISMA diagram for study selection is shown in Figure 1.

Figure 2

Forest plot on the prevalence of sarcopenia in community-dwelling Men – total and divided in three subgroups (Asian, non-Asian and European)



Meta-analysis

The overall prevalence of sarcopenia in the included studies were 14% (95% CI: 11-17%) in men and 12% (95% CI: 10-15%) in women. Substantial heterogeneity observed in men (Q=1186.45, p=0.00, I2=96%) and women (Q=1188.18, p=0.00, I2=96%).

Because of the major differences in the prevalence of sarcopenia among community-dwelling individuals (10% prevalence), nursing-home individuals (38% prevalence) and hospitalized individuals (23% prevalence) as shown in figure 6, we examined these populations separately analyzing extensively only the community-dwelling group.

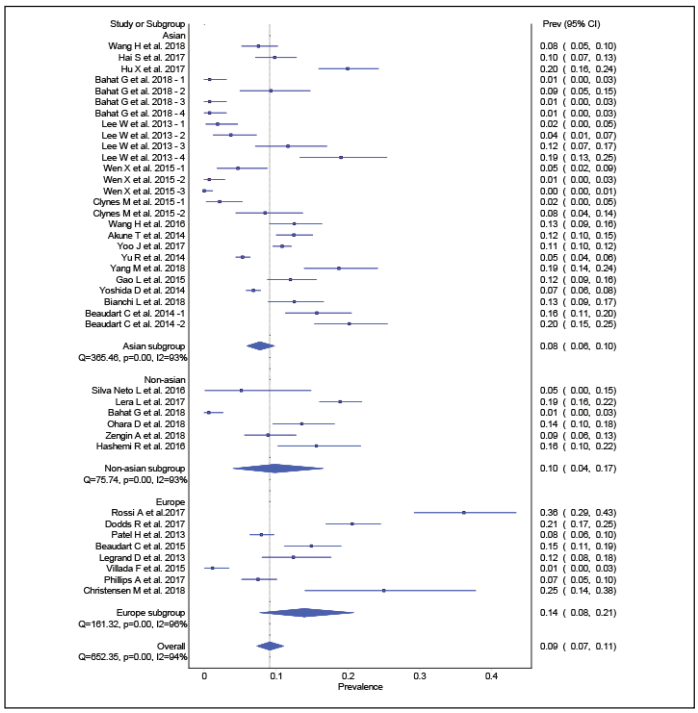
Community Dwelling individuals

The prevalence of sarcopenia in community dwelling individuals in the included studies were 11% (95% CI: 8-13%) in men and 9% (95% CI: 7-11%) in women. Substantial heterogeneity observed in men (Q= 770.68, p=0.00, I2=95%) and women (Q= 652.35, p=0.00, I2=94%).

According to the Doi plot and the value of the LFK index equaled 0.93 (no asymmetry) in men and 0.00 (no asymmetry) in women, there is no publication bias being identified.

Figure 3

Forest plot on the prevalence of sarcopenia in community-dwelling Women – total and divided in three subgroups (Asian, non-Asian and European)



Subgroup Analysis

Muscle mass assessment methods

According to the muscle mass assessment method (DXA, BIA and anthropometrics), the prevalence of sarcopenia in community dwelling men was 11%, 9% and 9% accordingly and in women was 8%, 10% and 13%.

Countries

Community dwelling individuals living in non-Asian countries were found more likely to be sarcopenic than those living in Asian countries. This was true among both genders (13% vs 9% in men, 11% vs 8% in women). The prevalence of sarcopenia in Europe was 13% for men and 14% for women.

Criteria

There is a small difference in the prevalence of sarcopenia in community dwelling men and women according to the criteria used. In community dwelling men the prevalence ranges from 11%, 12% and 8% using EWGSOP, AWGS and IWGS criteria accordingly and in women ranges from 10%, 11% and 5% using EWGSOP, AWGS and IWGS criteria accordingly.

Nursing home/hospitalized individuals

The prevalence of sarcopenia in nursing-home individuals in the included studies were 51% (95% CI: 37-66%) in men and 31% (95% CI: 22-42%) in women and in hospitalized individuals were 23% (95%, CI: 15-30%) in men and 24% (95% CI: 14-35%) in women.

Figure 4

Forest plot on the prevalence of sarcopenia in community-dwelling Men divided in subgroups by criteria (EWGSOP, AWGS, IWGS)

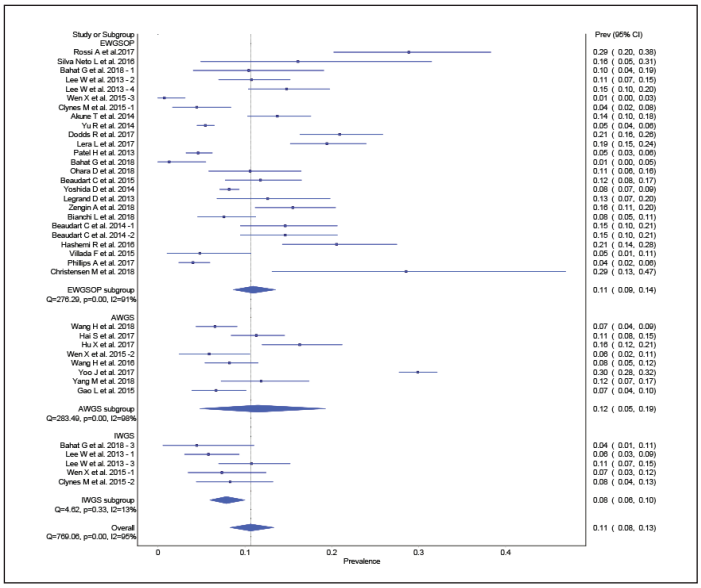


Figure 5

Forest plot on the prevalence of sarcopenia in community-dwelling Women divided in subgroups by criteria (EWGSOP, AWGS, IWGS)

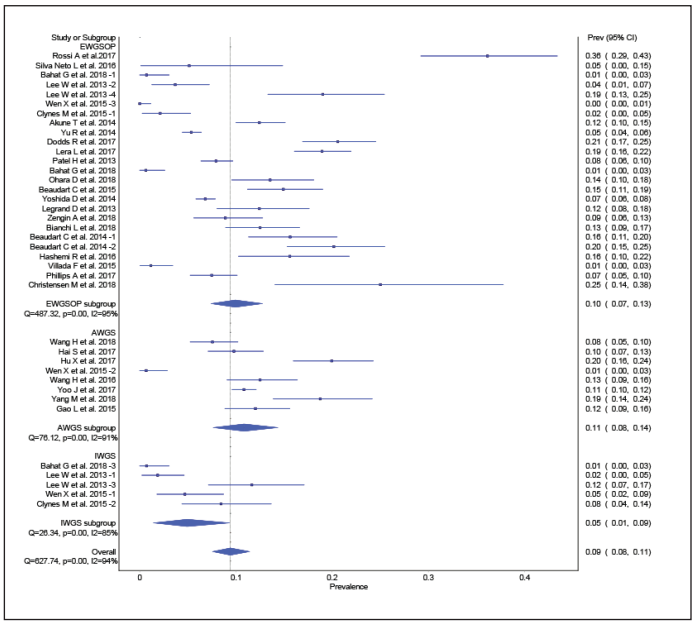
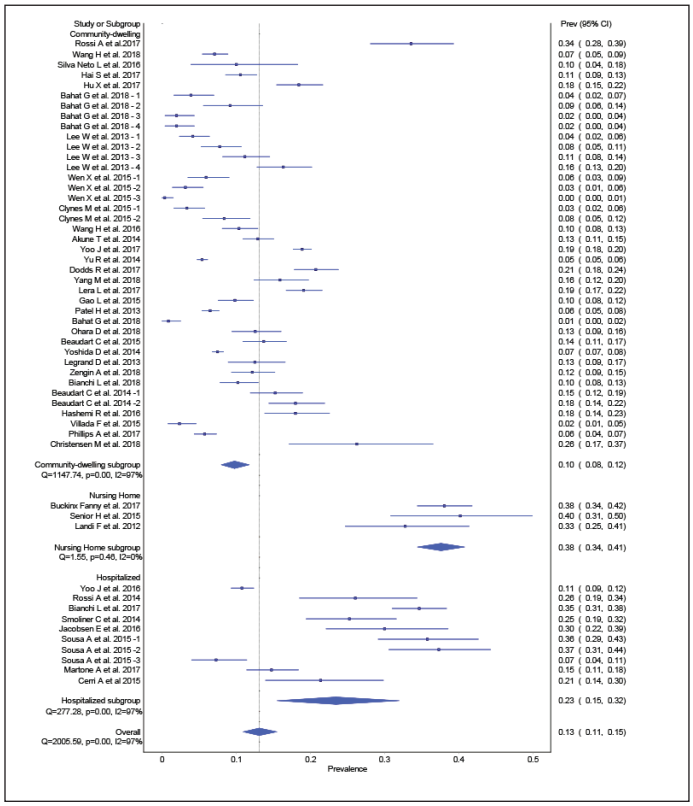


Figure 6

Forest plot on the prevalence of sarcopenia divided in subgroups by population. The prevalence of sarcopenia in community-dwelling individuals is 10%, in nursing-home individuals is 38% and in hospitalized individuals is 23%



Discussion

Sarcopenia is considered to be an independent risk factor for various adverse outcomes, including difficulties in basic and instrumental ADL, osteoporosis, falls, length of stay at the hospital and re-admission as well as death (46).

The prevalence of sarcopenia in the literature varies widely and is likely to be affected by the population studied (community-dwelling, nursing homes and hospitals), the criteria used (EWGSOP, AWGS, IWGS) and the different methods utilized to assess muscle mass, muscle strength and physical performance.

In our study we found that in non-Asian countries, the prevalence of sarcopenia was more likely than in the Asian community dwelling individuals (13% vs 9% in men, 11% vs 8% in women). These results can be attributed to various factors such as racial characteristics, body size, cultural background, dietary regimes, and life quality of the elderly between the Asian and non-Asian individuals in different countries. Also, the cut-off points for the Asian populations are lower than for the non-Asian individuals in both genders, with young people of the same ethnic group as reference (47).

Table 1
Characteristics of studies included in this meta-analysis

Studies	Region	Population	Sample (N) Total-Male-Female	Criteria	Assessment method for muscle mass	Total N	Male N	Female N
Rossi A et al.2017 (8)	Italy	Community-dwelling	274-97-177	EWGSOP	DXA	92	28	64
Wang H et al. 2018 (9)	China	Community-dwelling	865-427-438	AWGS	BIA	61	28	33
Silva Neto L et al. 2016 (10)	Brazil	Community-dwelling	70-31-39	EWGSOP	DXA	7	5	2
Hai S et al. 2017 (11)	China	Community-dwelling	834-415-419	AWGS	BIA	88	47	41
Hu X et al. 2017 (12)	China	Community-dwelling	607-251-356	AWGS	Anthropometric equation ASM	112	41	71
Bahat G et al. 2018 (13)	Turkey	Community-dwelling	207-67-140		BIA			
1				EWGSOP		8	7	1
2				FNIH		19	6	13
3				IWGS		4	3	1
4				SCWD		4	4	1
Lee W et al. 2013 (5)	Taiwan	Community-dwelling	386-223-163		DXA			
1				IWGS		16	13	3
2				EWGSOP		30	24	6
3				IWGS		43	24	19
4				EWGSOP		63	33	31
Wen X et al. 20151 (4)	China	Community-dwelling	286-136-150		Anthropometric equation ASM			
1				IWGS		17	10	7
2				AWGS		9	8	1
3				EWGSOP		1	1	0
Clynes M et al. 20151 (5)	UK	Community-dwelling	298-156-142		DXA			
1		Community-dwelling		EWGSOP		10	7	3
2		Community-dwelling		IWGS		25	13	12
Wang H et al. 2016 (7)	China	Community-dwelling	636-316-320	AWGS	DXA and BIA	66	26	40
Akune T et al. 2014 (16)	Japan	Community-dwelling	1000-349-651	EWGSOP	BIA	129	48	81
Yoo J et al. 2017 (17)	Korea	Community-dwelling	4020-1698-2322	AWGS	DXA	759	508	251
Yu R et al. 2014 (18)	China	Community-dwelling	4000-2000-2000	EWGSOP	DXA	216	109	107
Dodds R et al. 2017 (19)	UK	Community-dwelling	719-282-437	EWGSOP	BIA	149	59	90
Yang M et al. 2018 (20)	China	Community-dwelling	384-160-224	AWGS	BIA	61	19	42
Lera L et al. 2017 (21)	Chile	Community-dwelling	1006-319-687	EWGSOP	DXA	192	62	130
Gao L et al. 2015 (22)	China	Community-dwelling	612-254-358	AWGS	Anthropometric measures	60	17	43
Patel H et al. 2013 (23)	UK	Community-dwelling	1787-765-1022	EWGSOP	FFM	116	35	81
Bahat G et al. 2018 (24)	Turkey	Community-dwelling	242-77-165	EWGSOP	BIA	2	1	1
Ohara D et al. 2018 (25)	Brazil	Community-dwelling	383-132-251	EWGSOP	Equation TMM	48	14	34
Beaudart C et al. 2015 (26)	Belgium	Community-dwelling	534-212-322	EWGSOP	DXA	73	25	48
Yoshida D et al. 2014 (27)	Japan	Community-dwelling	4811-2343-2468	EWGSOP	BIA	360	192	168
Legrand D et al. 2013 (28)	Belgium	Community-dwelling	288-103-185	EWGSOP	BIA	36	13	23
Zengin A et al. 2018 (29)	Gambia	Community-dwelling	486-238-248	EWGSOP	DXA	59	37	22
Bianchi L et al. 2016 (30)	Italy	Community-dwelling	538-250-288	EWGSOP	BIA	55	19	36
Beaudart C et al. 2014 (31)	Belgium	Community-dwelling	400-157-243	EWGSOP	DXA			
1						61	23	38
2						72	23	49
Hashemi R et al. 2016 (32)	Iran	Community-dwelling	300-146-154	EWGSOP	DXA	54	30	24
Villada F et al. 2015 (33)	Spain	Community-dwelling	258-83-175	EWGSOP	DXA	6	4	2
Phillips A et al. 2017 (34)	Germany	Community-dwelling	927-473-454	EWGSOP	BIA	53	19	34
Christensen M et al. 2018 (35)	Denmark	Community-dwelling	80-28-52	EWGSOP	DXA	21	8	13
Yoo J et al. 2016 (36)	Korea	Hospitalized	1614-664-950	AWGS	DXA	174	107	67

Table 1 (continued)
Characteristics of studies included in this meta-analysis

Studies	Region	Population	Sample (N) Total-Male-Female	Criteria	Assessment method for muscle mass	Total N	Male N	Female N
Rossi A et al. 2014 (37)	Italy	Hospitalized	119-78-41	EWGSOP	BIA	31	13	18
Bianchi L et al. 2017 (38)	Italy	Hospitalized	655-315-340	EWGSOP	BIA	227	115	112
Smoliner C et al. 2014 (39)	Germany	Hospitalized	198-59-139	EWGSOP	BIA	50	20	30
Buckinx Fanny et al. 2017 (40)	Belgium	Nursing home	662-182-480	EWGSOP	BIA	252	78	174
Senior H et al. 201 (51)	Australia	Nursing home	102-31-71	EWGSOP	BIA	41	15	26
Landi F et al. 2012 (41)	Italy	Nursing home	122-31-91	EWGSOP	BIA	40	21	19
Jacobsen E et al. 2016 (42)	Norway	Hospitalized	120-44-76	EWGSOP	anthropometric measures MAMC	36	3	33
Sousa A et al. 2015 (43)	Portugal	Hospitalized	193-112-81		BIA			
1				EWGSOP		69	38	31
2				EWGSOP		72	46	26
3				EWGSOP		14	10	4
Martone A et al. 2017 (44)	Italy	Hospitalized	394-183-211	EWGSOP	BIA	58	29	29
Cerri A et al 2015 (45)	Italy	Hospitalized	103-42-61	EWGSOP	BIA	22	10	12

Most of the studies we included used the Bio-electrical Impedance Analysis (BIA, 21 studies) to asses muscle mass, followed by the Dual Energy X-Ray Absorptiometry (DXA, 15 studies) and anthropometric equations (6 studies). The prevalence of sarcopenia varies according to the tool used to measure muscle mass. BIA is known to underestimate fat mass and overestimate muscle mass (49). Previous studies found that the BIA-based prevalence of sarcopenia was higher than the DXA- based approach (50, 51). In our study we found that according to the muscle mass assessment method (DXA, BIA and anthropometrics), the prevalence of sarcopenia in community dwelling men was 11%, 9% and 9% accordingly and in women was 8%, 10% and 13%.

The overall pooled prevalence of sarcopenia among all populations in the included studies was higher in men (14%) and lower in women (12%). Epidemiological data for discordance in sarcopenia prevalence between older men and women have been conflicting. Several studies had suggested differential sex-specific rate of absolute muscle loss, being greater in men than in women, which could not be attributed merely to the larger initial muscle mass in men by interleukin-6 (IL-6) in women (48).

It is worth mentioning that we found a lower incidence of sarcopenia in the studies used the IWGS criteria in comparison with the EWGOP-based and AWGS-based studies. This was not surprising because EWGSOP and AWGS classify sarcopenia as low muscle strength with low muscle mass without low physical performance as IWGS does (5).

Our review is the first systematic review and meta-analysis to compare the differences in the prevalence of sarcopenia among different populations (community-dwelling, hospitalized, nursing home). Based on our findings, the most prevalent individuals to sarcopenia are the ones who live in nursing homes (38% incidence of sarcopenia) followed by the ones that are hospitalized (23% incidence of sarcopenia) and the least prevalent individuals who are community-dwelling (10% incidence of sarcopenia). One systematic review and meta-analysis done in 2018 found that the prevalence of sarcopenia in nursing homes is 41% (52), which is close to our results of 38%. Another meta-analysis done in 2017 found that the prevalence of sarcopenia in community dwelling individuals is 10%(47) which completely agrees with our results of 10%.

Physical activity and nutrition

A lot of studies state that higher physical activity levels are associated with lower sarcopenic risk (18). The physical activity and the nutritional status are some of the major factors that we found such a difference in the prevalence of sarcopenia in nursing homes and hospitalized patients (38% and 23%), who spend a lot of hours in bed and often do not have a choice of what foods to eat, in comparison to community dwelling individuals (10%) that are more physically active and choose their own foods.

Sarcopenic individuals in nursing homes reported more sitting time, were less likely to report being currently physical active and also were more likely to be malnourished (1, 40, 41).

Hospitalized individuals might represent an additional risk factor for sarcopenia and functional decline because of reduced caloric intake, low physical activity or prolonged bed-rest, depressed mood, and social isolation (38, 44).

Community-dwelling individuals are more likely to be sarcopenic if they are less physically active and don't have a good nutritional status (7, 11, 12, 18, 22).

It is also worth mentioning that sarcopenia may be less prevalent in Asian populations due to differences in lifestyle. These differences include better dietary aspect and higher levels of activity than the Western populations, which act as protective factors against sarcopenia (47).

Our review revealed that the currently available studies addressing sarcopenia in nursing homes and hospitals were generally small in sample size in comparison to the ones addressing community-dwelling individuals. Hence, there seem to be significant opportunities to expand our understanding of sarcopenia by carrying out further well-designed and well-reported studies to compare the various diagnostic criteria of sarcopenia on different populations for the prediction of death and other clinical outcomes (such as quality of life and hospitalization). It is also interesting to evaluate the use of targeted nutrition, nutritional supplements and exercise regimes on the outcomes of sarcopenia in nursing homes and hospitals.

Conclusion

Sarcopenia appears to be highly prevalent in older nursing home residents and hospitalized patients in comparison to community-dwelling individuals. Low physical activity and malnutrition may be two major factors associated with these results. Asian populations are less likely to be sarcopenic because of their different lifestyle than the Western populations. More well-designed RCTs are needed to determine the effects of nutritional supplements, exercise, and their combination for nursing home residents and hospitalized patients.

Conflict of Interest: None for all authors

References

1. Senior HE, Henwood TR, Beller EM, Mitchell GK, Keogh JWL. Prevalence and risk factors of sarcopenia among adults living in nursing homes. Maturitas. 2015;82(4):418-423. doi:10.1016/j.maturitas.2015.08.006
2. Martin FC, Schneider SM, Rolland Y, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412-423. doi:10.1093/ageing/afq034
3. Fielding RA, Vellas B, Evans WJ, et al. Sarcopenia: an undiagnosed condition in older adults. Current consensus definition: prevalence, etiology, and consequences. International working group on sarcopenia. J Am Med Dir Assoc. 2011;12(4):249-256. doi:10.1016/j.jamda.2011.01.003
4. Studenski SA, Peters KW, Alley DE, et al. The FNIH sarcopenia project: Rationale, study description, conference recommendations, and final estimates. Journals Gerontol - Ser A Biol Sci Med Sci. 2014;69 A(5):547-558. doi:10.1093/gerona/glu010
5. Lee WJ, Liu LK, Peng LN, Lin MH, Chen LK. Comparisons of Sarcopenia Defined by IWGS and EWGSOP Criteria Among Older People: Results From the I-Lan Longitudinal Aging Study. J Am Med Dir Assoc. 2013;14(7):528.e1-7. doi:10.1016/j.jamda.2013.03.019
6. Chen L-K, Liu L-K, Woo J, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc. 2014;15(2):95-101. doi:10.1016/j.jamda.2013.11.025
7. Wang H, Hai S, Cao L, Zhou J, Liu P, Dong BR. Estimation of prevalence of sarcopenia by using a new bioelectrical impedance analysis in Chinese community-dwelling elderly people. BMC Geriatr. 2016;16(1):1-9. doi:10.1186/s12877-016-0386-z
8. Rossi AP, Micciolo R, Rubele S, et al. Assessing the risk of sarcopenia in the elderly: The Mini Sarcopenia Risk Assessment (MSRA) questionnaire. J Nutr Heal Aging. 2017;21(6):743-749. doi:10.1007/s12603-017-0921-4
9. Wang H, Hai S, Liu YY, et al. Association between depressive symptoms and sarcopenia in older Chinese community-dwelling individuals. Clin Interv Aging. 2018;Volume 13:1605-1611. doi:10.2147/CIA.S173146
10. Silva Neto LS, Karnikowski MGO, Osório NB, et al. Association between sarcopenia and quality of life in quilombola elderly in Brazil. Int J Gen Med. 2016;9:89-97. doi:10.2147/IJGM.S92404
11. Hai S, Wang H, Cao L, et al. Association between sarcopenia with lifestyle and family function among community-dwelling Chinese aged 60 years and older. BMC Geriatr. 2017;17(1):187. doi:10.1186/s12877-017-0587-0
12. Hu X, Jiang J, Wang H, Zhang L, Dong B, Yang M. Association between sleep duration and sarcopenia among community-dwelling older adults. Med (United States). 2017;96(10):e6268. doi:10.1097/MD.0000000000006268
13. Bahat G, Oren MM, Yilmaz O, Kiliç C, Aydin K, Karan MA. Comparing SARC-F with SARC-CalF to Screen Sarcopenia in Community Living Older Adults. J Nutr Heal Aging. 2018;22(9):1-5. doi:10.1007/s12603-018-1072-y
14. Wen X, An P, Chen WC, Lv Y, Fu Q. Comparisons of sarcopenia prevalence based on different diagnostic criteria in Chinese older adults. J Nutr Heal Aging. 2015;19(3):342-347. doi:10.1007/s12603-014-0561-x
15. Clynes MA, Edwards MH, Buehring B, Dennison EM, Binkley N, Cooper C. Definitions of Sarcopenia: Associations with Previous Falls and Fracture in a Population Sample. Calcif Tissue Int. 2015;97(5):445-452. doi:10.1007/s00223-015-0044-z
16. Akune T, Muraki S, Oka H, et al. Exercise habits during middle age are associated with lower prevalence of sarcopenia: The ROAD study. Osteoporos Int. 2014;25(3):1081-1088. doi:10.1007/s00198-013-2550-z
17. Yoo J Il, Ha YC, Lee YK, Hana-Choi, Yoo MJ, Koo KH. High prevalence of sarcopenia among binge drinking elderly women: a nationwide population-based study. BMC Geriatr. 2017;17(1):114. doi:10.1186/s12877-017-0507-3
18. Yu R, Wong M, Leung J, Lee J, Auyeung TW, Woo J. Incidence, reversibility, risk factors and the protective effect of high body mass index against sarcopenia in community-dwelling older Chinese adults. Geriatr Gerontol Int. 2014;14(SUPPL.1):15-28. doi:10.1111/ggi.12220
19. Dodds RM, Granic A, Davies K, Kirkwood TBL, Jagger C, Sayer AA. Prevalence and incidence of sarcopenia in the very old: findings from the Newcastle 85+ Study. J Cachexia Sarcopenia Muscle. 2017;8(2):229-237. doi:10.1002/jcsm.12157
20. Yang M, Hu X, Xie L, et al. Screening Sarcopenia in Community-Dwelling Older Adults: SARC-F vs SARC-F Combined With Calf Circumference (SARC-CalF). J Am Med Dir Assoc. 2018;19(3):277.e1-277.e8. doi:10.1016/j.jamda.2017.12.016
21. Lera L, Albala C, Sánchez H, et al. Prevalence of Sarcopenia in Community-Dwelling Chilean Elders According to an Adapted Version of the European Working Group on Sarcopenia in Older People (EWGSOP) Criteria. J frailty aging. 2017;6(1):12-17. doi:10.14283/jfa.2016.117
22. Gao L, Jiang J, Yang M, Hao Q, Luo L, Dong B. Prevalence of Sarcopenia and Associated Factors in Chinese Community-Dwelling Elderly: Comparison Between Rural and Urban Areas. J Am Med Dir Assoc. 2015;16(11):1003.e1-1003.e6. doi:10.1016/j.jamda.2015.07.020
23. Patel HP, Syddall HE, Jameson K, et al. Prevalence of sarcopenia in community-dwelling older people in the UK using the European Working Group on Sarcopenia in Older People (EWGSOP) definition: findings from the Hertfordshire Cohort Study (HCS). Age Ageing. 2013;42(3):378-384. doi:10.1093/ageing/afs197
24. Bahat G, Tufan A, Kilic C, Karan MA, Cruz-Jentoft AJ. Prevalence of sarcopenia and its components in community-dwelling outpatient older adults and their relation with functionality. Aging Male. October 2018:1-7. doi:10.1080/13685538.2018.1511976
25. Ohara DG, Pegorari MS, Oliveira dos Santos NL, et al. Respiratory Muscle Strength as a Discriminator of Sarcopenia in Community-Dwelling Elderly: A Cross-Sectional Study. J Nutr Health Aging. 2018;22(8):952-958. doi:10.1007/s12603-018-1079-4
26. Beaudart C, Reginster JY, Petermans J, et al. Quality of life and physical components linked to sarcopenia: The SarcoPhAge study. Exp Gerontol. 2015;69:103-110. doi:10.1016/j.exger.2015.05.003
27. Yoshida D, Suzuki T, Shimada H, et al. Using two different algorithms to determine the prevalence of sarcopenia. Geriatr Gerontol Int. 2014;14(SUPPL.1):46-51. doi:10.1111/ggi.12210
28. Legrand D, Vaes B, Matheï C, Swine C, Degryse JM. The prevalence of sarcopenia in very old individuals according to the european consensus definition: Insights from the belfrail study. Age Ageing. 2013;42(6):727-734. doi:10.1093/ageing/aft128
29. Zengin A, Jarjou LM, Prentice A, Cooper C, Ebeling PR, Ward KA. The prevalence of sarcopenia and relationships between muscle and bone in ageing West-African Gambian men and women. J Cachexia Sarcopenia Muscle. 2018;9(5):920-928. doi:10.1002/jcsm.12341
30. Bianchi L, Ferrucci L, Cherubini A, et al. The Predictive Value of the EWGSOP Definition of Sarcopenia: Results From the InCHIANTI Study. Journals Gerontol - Ser A Biol Sci Med Sci. 2016;71(2):259-264. doi:10.1093/gerona/glv129
31. Beaudart C, Reginster J-Y, Slomian J, Buckinx F, Locquet M, Bruyère O. Prevalence of sarcopenia: the impact of different diagnostic cut-off limits. J Musculoskelet Neuronal Interact. 2014;14(4):425-431. doi:10.1007/s10843-015-0156-6
32. Hashemi R, Shafiee G, Motlagh AD, et al. Sarcopenia and its associated factors in Iranian older individuals: Results of SARIR study. Arch Gerontol Geriatr. 2016;66:18-22. doi:10.1016/j.archger.2016.04.016
33. Villada FAP, Franco SAA, De Paz Fernández JA. Sarcopenia en personas mayores de 60 años residentes en la comunidad de una ciudad del norte de españa: Relación entre sus criterios diagnósticos y asociación con el rendimiento funcional. Nutr Hosp.

2015;31(5):2154-2160. doi:10.3305/nh.2015.31.5.8002
34. Phillips A, Strobl R, Vogt S, Ladwig KH, Thorand B, Grill E. Sarcopenia is associated with disability status—results from the KORA-Age study. Osteoporos Int. 2017;28(7):2069-2079. doi:10.1007/s00198-017-4027-y
35. Christensen MG, Piper KS, Dreier R, Suetta C, Andersen HE. Prevalence of sarcopenia in a Danish geriatric out-patient population. Dan Med J. 2018;65(6).
36. Yoo J Il, Ha YC, Kwon H Bin, Lee YK, Koo KH, Yoo MJ. High prevalence of sarcopenia in Korean patients after hip fracture: A case-control study. J Korean Med Sci. 2016;31(9):1479-1484. doi:10.3346/jkms.2016.31.9.1479
37. Rossi AP, Fantin F, Micciolo R, et al. Identifying Sarcopenia in Acute Care Setting Patients. J Am Med Dir Assoc. 2014;15(4):303.e7-12. doi:10.1016/j.jamda.2013.11.018
38. Bianchi L, Abete P, Bellelli G, et al. Prevalence and Clinical Correlates of Sarcopenia, Identified According to the EWGSOP Definition and Diagnostic Algorithm, in Hospitalized Older People: The GLISTEN Study. Journals Gerontol - Ser A Biol Sci Med Sci. 2017;72(11):1575-1581. doi:10.1093/gerona/glw343
39. Smoliner C, Sieber CC, Wirth R. Prevalence of sarcopenia in geriatric hospitalized patients. J Am Med Dir Assoc. 2014;15(4):267-272. doi:10.1016/j.jamda.2013.11.027
40. Buckinx F, Reginster JY, Brunois T, et al. Prevalence of sarcopenia in a population of nursing home residents according to their frailty status: Results of the SENIOR cohort. J Musculoskelet Neuronal Interact. 2017;17(3):209-217. doi:http://dx.doi.org/10.1007/s00198-016-3520-z
41. Landi F, Liperoti R, Fusco D, et al. Prevalence and risk factors of sarcopenia among nursing home older residents. Journals Gerontol - Ser A Biol Sci Med Sci. 2012;67 A(1):48-55. doi:10.1093/gerona/glr035
42. Jacobsen EL, Brovold T, Bergland A, Bye A. Prevalence of factors associated with malnutrition among acute geriatric patients in Norway: a cross-sectional study. BMJ Open. 2016;6(9):e011512. doi:10.1136/bmjopen-2016-011512
43. Sousa AS, Guerra RS, Fonseca I, Pichel F, Amaral TF. Sarcopenia among hospitalized patients - A cross-sectional study. Clin Nutr. 2015;34(6):1239-1244. doi:10.1016/j.clnu.2014.12.015
44. Martone AM, Bianchi L, Abete P, et al. The incidence of sarcopenia among hospitalized older patients: results from the Glisten study. J Cachexia Sarcopenia Muscle. 2017;8(6):907-914. doi:10.1002/jcsm.12224
45. Cerri AP, Bellelli G, Mazzone A, et al. Sarcopenia and malnutrition in acutely ill hospitalized elderly: Prevalence and outcomes. Clin Nutr. 2015;34(4):745-751. doi:10.1016/j.clnu.2014.08.015
46. Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interventions for sarcopenia in ageing adults: A systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). Age Ageing. 2014;43(6):48-759. doi:10.1093/ageing/afu115
47. Shafiee G, Keshtkar A, Soltani A, Ahadi Z, Larijani B, Heshmat R. Prevalence of sarcopenia in the world: A systematic review and meta- analysis of general population studies. J Diabetes Metab Disord. 2017;16(1):21. doi:10.1186/s40200-017-0302-x
48. Tay L, Ding YY, Leung BP, et al. Sex-specific differences in risk factors for sarcopenia amongst community-dwelling older adults. Age (Omaha). 2015;37(6):1-12. doi:10.1007/s11357-015-9860-3
49. Janssen IAN, Heymsfield SB, Baumgartner RN, et al. Estimation of skeletal muscle mass by bioelectrical impedance analysis. 2000:465-471.
50. Lee JSW, Auyeung T, Lau EMC, Leung P, Woo J. Associated Factors and Health Impact of Sarcopenia in Older Chinese Men and Women : A Cross-Sectional Study. 2007:404-410. doi:10.1159/000107355
51. Chien M-Y, Huang T-Y, Wu Y-T. Prevalence of sarcopenia estimated using a bioelectrical impedance analysis prediction equation in community-dwelling elderly people in Taiwan. J Am Geriatr Soc. 2008;56(9):1710-1715. doi:10.1111/j.1532-5415.2008.01854.x
52. Shen Y, Chen J, Chen X, Hou LS, Lin X, Yang M. Prevalence and Associated Factors of Sarcopenia in Nursing Home Residents: A Systematic Review and Meta-analysis. Journal of the American Medical Directors Association. https://doi.org/10.1016/j.jamda.2018.09.012. Published January 2018.
53. Alfonso J Cruz-Jentoft, Gülistan Bahat, Jürgen Bauer, Yves Boirie, Olivier Bruyère, Tommy Cederholm, Cyrus Cooper, Francesco Landi, Yves Rolland, Avan Aihie Sayer, Stéphane M Schneider, Cornel C Sieber, Eva Topinkova, Maurits Vandewoude, Marjolein Visser, Mauro Zamboni, Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2, Sarcopenia: revised European consensus on definition and diagnosis, Age and Ageing, Volume 48, Issue 1, January 2019, Pages 16–31, https://doi.org/10.1093/ageing/afy169